OCA-T-4
Docket No. R2000-1

DIRECT TESTIMONY

OF

J. EDWARD SMITH

ON BEHALF OF

THE OFFICE OF THE CONSUMER ADVOCATE

MAY 22, 2000

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UNITED STATES OF AMERICA
Before The
POSTAL RATE COMMISSION
WASHINGTON, D.C. 20268-0001

Postal Rate and Fee Changes, 2000) Docket No. R2000-1

DIRECT TESTIMONY OF J. EDWARD SMITH

I. STATEMENT OF QUALIFICATIONS

My name is J. Edward Smith, and I am an econometrician with the Office of the Consumer Advocate of the Postal Rate Commission. I have previously worked in a variety of economic assignments in industrial, academic, consulting, and governmental positions. My experience has focused on the modeling of costs and revenues; economic analysis related to forecasting, project analysis, production and strategic planning; and rates, prices, marketing, and planning analysis. My economics degrees are an A.B. from Hamilton College, and an M.S. and Ph.D. from Purdue University. I have testified approximately 20 times before regulatory commissions, most recently before the Postal Rate Commission on mail processing volume variability in Docket No. R97-1.

II. PURPOSE AND SCOPE OF TESTIMONY

The purpose of my testimony is to evaluate the volume variability analysis for segment 3 mail processing costs presented by Dr. A. Thomas Bozzo.[1] Dr. Bozzo's work was a continuation of Dr. Michael D. Bradley's pioneering work on mail processing costs variability presented in Docket No. R97-1.[2] Volume variability measures the percentage change in cost with respect to the percentage change in volume. Dr. Bozzo measured the variability of cost, measured in hours worked, with respect to changes in the volume of mail, as measured in terms of total pieces handled (TPH) or total pieces fed (TPF).

Traditionally the Commission has assumed that mail processing volume variability is 100 percent. Dr. Bozzo measured variabilities for 10 mail processing activities and found variabilities ranging from 52 percent to 95 percent. Volume variability is an important issue, for segment 3 mail processing costs are in excess of $17 Billion, and the variabilities applied to the various cost pool costs associated with the activity are used to yield a measure of attributable costs. Costs that are not attributable become institutional, requiring that the Commission recommend assignment of the costs to various rates, classes and categories.

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1 Dr. Bozzo's testimony appears in this docket in USPS-T-15, Docket No. R2000-1.

2 Witness Bradley's testimony appeared in Docket No. R97-1 as USPS-T-14.

My evaluation of Dr. Bozzo's study is based on whether the study meets the following evaluation criteria mentioned by the Commission in Docket No. R97-1:[3]

1. A study should include the development and use of an adequate database, appropriately verified and complete.
2. The study should include a discussion of the modeling approach and how it is consistent with the underlying data.
3. An adequate model and analysis of functional properties is necessary.
4. A correct estimation procedure that is suitable to the estimation needs at hand should be used.
5. Results for econometric equations and alternative econometric analyses should include a full explanation of the values, signs, and other relevant information for the variables.

The Commission has also indicated some of the procedures by which it reviews econometric work:

1. First, the Commission reviews the econometric research using the criteria for evaluation.
2. Second, the Commission reviews the statistical properties of the estimates.
3. Finally, the Commission tries to identify a preferred model to find a result that it can safely rely upon: a result that is stable and robust.

In considering Dr. Bozzo's study I will first review Dr. Bradley's study (for purposes of providing a background and context evaluation). I will then discuss the

[3] Docket No. R97-1, *Opinion and Recommended Decision*, Volume 2, Appendix F at 1.

degree to which Dr. Bozzo's study meets the evaluation criteria. If the research fails to meet the criteria cited, the Commission may decline to accept the conclusions and apply traditional volume variabilities or apply the best of several unsatisfactory alternatives, pending further analysis.

My analysis of the database issue focuses on the scrubbing process and the adequacy of the variables. I address the modeling issues by focusing on the theoretical economic issues as impacting the modeling process. Estimation procedures can include a variety of econometric models. I discuss Dr. Bozzo's choice of the fixed effects model and possible alternatives. I comment on how the evaluation criteria could be reviewed by the Commission. Although Dr. Bozzo's study is a follow-on work to Dr. Bradley's study, many of the problems associated with the original study continue to be found in the revised study. I also comment on how the estimation process could be concluded in a way that could be satisfactory to all participants through the implementation of a working group.

III. INTRODUCTION: VOLUME VARIABILITY OF MAIL PROCESSING COSTS

A. Both Dr. Bradley and Dr. Bozzo Have Presented Analyses of Segment 3 Mail Processing Costs.

Volume variability for mail processing is defined as the percentage change in cost that results from a percentage change in volume, holding delivery points and other non-volume factors constant. Both Dr. Bradley and Dr. Bozzo measured costs in terms of person hours of segment 3 mail processing effort. Dr. Bradley measured volume in terms of total pieces handled (TPH), and Dr. Bozzo measured volume in terms of total pieces fed (TPF) or in some cases total pieces handled (TPH). The econometrically estimated variabilities of Drs. Bradley's and Bozzo's testimony are presented in Table 1.

The Postal Service operates over 38,000 offices, stations, branches, and processing and distribution centers providing for mail collection, processing and sorting, and delivery. The mail processing plants, where the segment 3 labor costs are generated, prepare the mail, sort the mail to three or five digits, and dispatch the mail to subsequent destinations for additional sorting or distribution. In his testimony in Docket No. R97-1, Dr. Bradley modeled 25 mail processing and handling activities at the major mail processing plants (denoted as MODS facilities) and at Bulk Mail Centers (BMCs).[4] Dr. Bozzo has limited his updated study to the analysis of ten mail sorting activities in the MODS operations. As was well documented in Docket No. R97-1, there was

[4] MODS offices perform the various sorting activities and report costs and volumes through the Management Operating Data System; non-MODS offices tend to be smaller, perform the same types of functions as do MODS offices, but do not report through the Management Operating Data Systems. There are over 300 MODS offices. The number of non-MODS offices is substantially larger. The 21 Bulk Mail Centers (BMCs) process packages and report their data through the Productivity Information Reporting System (PIRS).

significant disagreement with to Dr. Bradley's methodology, including serious problems with data scrubs and data checking, disagreement over the use of the fixed effects estimation approach. There was also concern about the lack of explanatory variables and the relationship of the econometric model to economic theory.

Mail processing costs comprise a significant portion of Postal Service costs. Total costs in the Base Year were $59.6 Billion, with segment 3 costs at $17.6 Billion.[5] According to witness Van-Ty-Smith, the segment 3 costs consist of $12.5 Billion in MODS offices, $0.8 Billion in BMCs, and $4.4 Billion in non-MODS facilities.[6] Dr. Bradley's testimony presented the first comprehensive analysis of volume variability. In his testimony, Dr. Bozzo traced the history of the assumption of 100% volume variability for segment 3 costs. He stated that the era of the assumption of 100 percent volume-variability was based on analysts' judgments by a task force formed in the late 1960's.[7] He testified that methodological, computational, and theoretical constraints had previously limited the econometric analyses of volume variability.

B. The Estimated Volume Variabilities Presented by Dr. Bradley and Dr. Bozzo Differ, but the Variabilities are in General Substantially Less than 100 Percent.

The estimated volume variabilities presented by Dr. Bradley and Dr. Bozzo in Table 1 are generally less than 100 percent.[8] The variabilities are subsequently used

5 Direct testimony of Karen Meehan, USPS-T-11, Exhibit 11A at 2 and 8.

6 Direct testimony of Eliane Van-Ty-Smith, USPS-T-17 at 24-25.

7 USPS-T-15 at 4, lines 7-18.

8 The discussion is limited to consideration of only those activities for which Dr. Bozzo presented estimated variabilities. In UPS/USPS-T15-9, Dr. Bozzo indicated that he had omitted 24 observations (continued on next page)

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by USPS Witness Van-Ty-Smith in conjunction with Pool Total Cost to compute Pool Volume-Variable Cost. Of the segment 3 Total Pool Cost of $5.4 Billion relevant to the variabilities estimated by Dr. Bozzo, the application of the variabilities developed by Dr. Bradley would lead to the conclusion that $4.4 Billion of cost would be volume variable. In comparison, the use of the variabilities developed by Dr. Bozzo would lead to the conclusion that $4.1 Billion would be volume variable. If the costs were 100 percent volume variable, then $5.4 Billion would be directly assigned.[9] Thus Dr. Bozzo's attribution proposal would reduce attributable costs by $1.3 Billion and increase institutional costs by a similar amount. This transfer of costs between accounting pools is of such a magnitude that it will most certainly influence the rates recommended by the Commission.

from the data set and reran the estimation of variabilities. However, the changes to the results were very minimal. Since the results were not statistically significant, he did not subsequently refile Appendix E. Accordingly, because the changes are *de minimis* and since the original numbers are clearly set forth in his testimony and can be considered statistically accurate, I am working with his written testimony as filed and adopted by him. None of my comments would change based on the information he has presented.

[9] USPS-T-17, Docket No. R2000-1 at 24, (Van-Ty-Smith).

Table 1
Mail Processing Activity

	Variabilities Dr. Bradley	Variabilities Dr. Bozzo	Total Cost $--000	Attributable Cost per Dr. Bradley $--000	Attributable Cost per Dr. Bozzo $--000
BCS Sorting	0.945	0.895	1,043,841	986,430	934,238
OCR Sorting	0.786	0.751	219,070	172,189	164,522
FSM Sorting	0.918	0.817	1,042,369	956,895	851,615
LSM	0.905	0.954	78,765	71,282	75,142
SPBS Non Priority	0.469	0.641	283,275	132,856	181,579
SPBS Priority	0.802	0.641	82,447	66,122	52,849
Manual Flats	0.866	0.772	459,933	398,302	355,068
Manual Letters	0.797	0.735	1,563,963	1,246,479	1,149,513
Manual Parcels	0.395	0.522	60,593	23,934	31,630
Manl. Priority Mail Srtg	0.448	0.522	259,762	116,373	135,596
Cancel. And Mail Prep.	0.654	0.549	295,957	193,556	162,480
Subtotal			5,389,975	4,364,418	4,094,231
Composite Variability				0.81	0.76

C. The Commission Has Identified Criteria and Standards that Can Serve as a Basis for the Evaluation of an Econometric Study.

The Commission discussed in Docket No. R97-1 the standards and criteria for the evaluation of an econometric analysis.[10] The Commission reviewed comments by witnesses Bradley, Neels, and Smith. The relevant criteria for the evaluation of the adequacy of an econometric study are well understood:

1. A study should include the development and use of an adequate database, appropriately verified and complete.
2. The study should include a discussion of the modeling approach and how it is consistent with the underlying data.
3. An adequate model and analysis of functional properties is necessary.

[10] Docket No. R97-1, *Appendices to Opinion and Recommended Decision*, Volume 2, Appendix F.

4. A correct estimation procedure that is suitable to the estimation needs at hand should be used.

5. Results for econometric equations and alternative econometric analyses should include a full explanation of the values, signs, and other relevant information for the variables.

The Commission has also indicated some of the procedures by which it reviews econometric work. First, the Commission reviews the econometric research using the criteria for evaluation. Second, the Commission reviews the statistical properties of the estimates. Finally, the Commission tries to identify a preferred model to find a result that it can safely rely upon; that is, a result that is stable and robust.

IV. DR. BRADLEY'S STUDY

A. A Review of Dr. Bradley's Study Highlights Previous and Potential Problems Associated with the Measurement of Volume Variability.

There were significant data, methodological and estimating problems associated with Dr. Bradley's original study. Unfortunately, these problems have carried over, in general, to Dr. Bozzo's study, so it is appropriate to first examine Dr. Bradley's study in some detail. Dr. Bradley's testimony presented two major conclusions that differed from the traditional assumptions about volume variability:

- There are differences in volume variabilities for mail processing across activities; and
- The estimation of mail processing variabilities generally produces a number less than 100 percent.

Both UPS witness Neels and I disputed the results, focusing on the variety of issues related to databases, variables, model specification, and other factors.[11] Dr. Bradley's estimation of mail processing was performed at the level of the individual mail processing activity. Table 2 summarizes Dr. Bradley's 25 estimated mail processing variabilities. Based on total mail processing labor costs disaggregated into activity-specific cost pools, Dr. Bradley estimated cost elasticities by modeling hours of labor (which he designated as a measure of cost) as a function of total pieces handled (TPH),

[11] UPS-T-1, Docket No. R97-1 (Neels); OCA-T-600, Docket No. R97-1 (Smith).

deemed to be a measure of output.[12] Additional explanatory variables included a segmented time trend, and a manual ratio (computed as the ratio of manual letter TPH to the sum of all manual letter TPH, mechanized letter TPH, and automated letter TPH). He also used seasonal dummy variables to denote the accounting periods to account for the ebbs and flows of mail throughout the year.

[12] This summary of Dr. Bradley's work is not comprehensive or complete, focusing only on the essential highlights of his work. For example, Registry and Encoding were separately estimated.

Table 2
Summary of Dr. Bradley's Variabilities

Activity	Variabilities Estimated by Dr. Bradley	Comparable Activities Estimated on the Basis of Proxies	Proxy Variability
MODS Offices		*General Support Activities*	
BCS Sorting	0.945	Mail Processing Support	System Variability
OCR Sorting	0.786	Miscellaneous Processing	System Variability
LSM Sorting	0.905	Empty equipment	System Variability
FSM Sorting	0.918	Damaged Parcel Rewrap	System Variability
Manual Letter Sorting	0.797	Piece Handlings Unavailable	
Manual Flat Sorting	0.866	Mechanized Sack Sorting	BMC Mech. SS
Manual Parcel Sorting	0.395	Mechanized Parcel Sorting	BMC Mech. PS
Manual Priority Mail Sorting	0.448	Bulk Presort	Opening Units
SPBS Priority Mail Sorting	0.802	Manual Sack sorting	BMC Platform
SPBS Non Priority Mail Sorting	0.469	Mailgram Sorting	Manual Ltr Sorting
Cancellation and Mail Prep	0.654	Express Mail Sorting	Manual Pri. Sorting
MODS Allied Activities		ACDCS (Scanning)	Pouching
Opening Pref Mail	0.720	Business Mail Reply	Manual Ltr Sorting
Opening Bulk Business Mail	0.741	*Customer Service Activities*	
Pouching	0.829	Automated Sorting/Stations	OCR & BCS
Platform	0.726	Mechanized Sorting/Stations	LSM and FSM Activities
Remote Encoding	1.000	Manual Sorting/Stations	Manl Lrt. and Manl. Flat
Registry	0.150	Box Section Sorting/Stations	Manl Lrt. and Manl. Flat
		Express Mail Sorting,CSOMan	Manual Pri. Sorting
BMC Offices		Special Service Activities	Registry Activity
Sack Sorting	0.991	Misc Activities at CSO	Registry Activity
Primary Parcel Sorting	0.854	Mail Markup and Forwarding	Avg. Mech. Activities
Secondary Parcel Sorting	0.969	Business Mail Entry	Platform Activity
Irregular Parcel Post	0.754		
Sack Opening Unit	0.718		
Non Machinable Outsides	0.672		
BMC Allied Activities			
Platform	0.533		
Floor Labor	0.605		

Data Sources
USPS-T-14, Docket No. R97-1, page 9.

B. Dr. Bradley's Study Was Criticized as Being of a Short-Run Nature Due to the Use of 4-Week Accounting Periods Coupled with the Lack of Consideration of Capital and Investment.

The Commission has indicated that the postal rate cycle, the period of time over which postal rates are fixed, is the appropriate time period for the purposes of

determining the relationship between costs and mail volume.[13] In contrast, Dr. Bradley's study focused on 4 week accounting periods along with some consideration of longer time frames. There was no longer-run consideration of costs as related to the facility expansion path,[14] which is the relevant approach to the measurement of costs. The Commission indicated that the cyclical nature of mail volume over a rate cycle implied that the relationship between input use and mail volume across adjacent accounting periods will reflect, primarily, seasonal variation in mail volume. Large changes in volume across accounting periods can occur with little change in labor hours across accounting periods, leading to a low variability estimate. I will subsequently show that Dr. Bozzo's study is also short run: the use of quarterly data, and even a "same period last year" analysis, does not change its short-run nature.

C. The Database for Dr. Bradley's Study Was Unreliable.

The MODS and PIRS databases provided observations by accounting period (AP) and site for the years 1988-1996. Dr. Bradley scrubbed the data for accuracy, continuity, and adequacy, resulting in the establishment of a database consisting of data by site, accounting periods, and activities. The data sets were large, with up to 25,000 observations or more.[15] Although the database was large when measured in terms of quantity of data, the major relevant data generated from a field site and used in

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[13] Docket No. R97-1, *Opinion and Recommended Decision*, Volume 2, Appendix F at 13.

[14] The expansion path is the equilibrium point of costs as facility size changes.

[15] Data sets were typically in the 17,000-25,000 observations range after scrubbing. A few data sets were significantly smaller.

the study (exclusive of information relating to facility identification, activity type, and time periods) consisted only of two variables: hours and TPH. Furthermore, the accuracy of the MODS data was substantially criticized. Dr. Bradley concluded that extensive data scrubbing was necessary. Substantial argument concerning the deficiencies of Dr. Bradley's scrubbing process generally focused on the elimination of relevant data. The scrubbing process appeared to be largely statistically based; there did not appear to have been a detailed review of the data with field personnel. Information on capital, facility characteristics and a variety of other data relevant to the analysis of mail processing were not included in the data set.

D. Dr. Bradley's Fixed Effects Approach Was Criticized by the Commission

Dr. Bradley estimated the relationship between hours and TPH with a translog function, using a fixed effects approach for the econometric estimation. In the analysis of a specific activity, he asserted that the fixed effects intercept was adequate to account for differences between facilities.[16] In selecting the estimation method for the translog function, Dr. Bradley considered three estimation approaches as possible choices:

- **Pooled:** If this approach had been used, then according to Dr. Bradley the approach would have been based on the assumption that facility-specific

[16] An issue that was not considered was whether some degree of segmentation into data subsets for the facilities would have improved the estimation process. Instead, Dr. Bradley assumed that the fixed effects approach would account for the differences.

characteristics were not important.[17] Dr. Bradley indicated that he rejected the pooled model approach for this reason, relying on the Gauss-Newton Regression (GNR). He stated that in every case the GNR tests indicated that the facility-specific effects were important and that both the pooled and the cross sectional models were not appropriate.

- **Fixed Effects:** The reasons cited for the differences in hours between facilities included the age of the facility, the quality of the local work force, and the quality of the mail that the facility must process.[18] Dr. Bradley indicated that his experience in studying mail-processing activities strongly suggested that there were significant non-volume variations across facilities as indicated by a Gauss-Newton Regression.[19] The fixed effects approach attempts to capture differences between facilities not captured by the variables in the equations, as measured by the intercept. However, the approach works only in measuring fixed effects at a site when the fixed effects never change.
- **Random Effects:** Dr. Bradley rejected the random effects model, and no participating party advocated such a model. Such an approach would be based on the assumption that the facility specific characteristics that cause productivity to vary across facilities are non-stochastic.

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[17] To the degree that data modeling the characteristics of a facility could be developed, such data could be included in the study as exogenous variables.

[18] USPS-T-14, Docket No. R97-1 at 40, lines 1 through 4.

[19] This is a key point. Subsequent testimony will disagree with some of the findings, and this has a key impact on conclusions. Dr. Bozzo also used a fixed effects approach. He appears to have provided inadequate explanation and response to the Commission's comments on fixed effects.

The Commission found that the fixed effects in Dr. Bradley's study may represent effects that are both related and unrelated to postal volumes; for example, the size of the facilities, included in the fixed effects, can be a function of the volume of mail. Accordingly, the Commission found that if the fixed effects were volume variable, then the computed volume variabilities were incorrect. Dr. Bozzo has again used the fixed effects estimating procedure.

E. Dr. Bradley Extrapolated His Econometric Results to a Number of Other Activities.

Dr. Bradley performed the analysis of mail sortation for a limited number of activities at MODS offices and BMCs. The results did not entirely meet witness Degen's needs, for Mr. Degen was required to form cost pools for certain activities that had no recorded workload measures. Since workload measures were unavailable, variabilities could not be measured econometrically. Therefore, Dr. Bradley used activities for which he had computed variabilities as proxies for activities for which he had been unable to compute variabilities. Finally, he extrapolated the results for variabilities for mail handling activities to non-MODS offices.[20] Dr. Bradley's conclusion that cost variabilities for mail processing activities are less than one was a major change from the traditional 100 percent assumption. He commented on his understanding of why variabilities are less than one:

- the existence of relatively fixed functions within the activity,

[20] USPS-T-14, Docket No. R97-1, Section V at 86-90.

- the division and specialization of labor (leading to the conclusion that manual activities should have increased efficiency), and
- technological change, resulting in machine paced activities operated at the same speed having a high variability.[21]

He indicated that gateway activities (*e.g.*, OCR and platform) would run at both low and high levels depending on the time of day. Finally, he assumed backstop activities would tend to have lower variabilities.[22]

[21] USPS-T-14, Docket No. R97-1 at 56.

[22] USPS-T-14, Docket No. R97-1 at 58.

V. DR. BOZZO'S VOLUME VARIABILITY STUDY

A. Dr. Bozzo's Revisions of 10 of the 25 Mail Processing Activities Modeled by Dr. Bradley Continue to Have Deficiencies.

Dr. Bozzo made a number of changes to Dr. Bradley's methodology; however, the approach continues to be fatally flawed.

(1) Dr. Bozzo's approach continues the short run approach to estimation. In the previous study, the mail processing elasticities only reflected the response of costs to volume changes on an eight weeks basis. Dr. Bozzo has modified the data to a quarterly basis, but the analysis is still based on short run costs, measuring changes in cost with respect to volume but not adequately addressing issues of capacity utilization and investment--which can have a significant impact on longer-run costs through their effects on facility expansion. Movements along a facility expansion path in response to volume changes will occur when capital and labor vary on a longer-term basis as a result of the Postal Service's investment plans. The expansion path is the hyperplane that should be measured, not the short run hours/TPF relationship.

(2) There is less data scrubbing, but the rules for the data scrubbing are not significantly better. There was apparently no discussion with field based personnel of the data on a site by site basis for data items suspect (unless required to answer an interrogatory).

(3) Microeconomic theory related to cost, production, and factor demand functions is interspersed with comments on non-cost minimization, homotheticity, and a variety of other sophisticated concepts. However, the theory is not presented in an

organized form. There appears to be a number of theoretical errors. This is not a trivial issue. The treatment of capital could potentially have a significant effect on the conclusions, but it is not clear whether capital is an exogenous or endogenous variable and whether some type of reduced form simultaneous equations system is needed.

(4) Variables assumed non-volume variable that are actually volume variable: the manual ratio is still present, and capital is treated as exogenous when it may in fact be endogenous.

(5) The economic theory does not appear to be well tied to the mail processing field realities. There is a major difference between the model estimated by Dr. Bozzo and the alternative model that can be developed from Mr. Degen's testimony.

(6) Dr. Bozzo has incorporated capital in the analysis; however, the actual measurement of capital appears to be inaccurate or inapplicable.

(7) The econometric methodology continues to be fixed effects, even though the major deficiencies of this approach were discussed in detail in the previous case.

(8) There has been some introduction of additional variables, for example, the consideration of networks. However, a potentially key variable--capacity utilization--is missing. The previously discredited manual ratio continues to be used.

B. Dr. Bozzo's Study Needs Substantial Work for Completion.

The analysis of mail processing facilities is a complex, intellectually challenging issue. The volume variability analysis has consumed major resources, apparently up to five years for the initial work presented by Dr. Bradley, and another five person years of

work for the work presented by Dr. Bozzo, which was, however, performed on a much more limited scope of activities. Possibly another five person years of effort would be required to complete the work.

Furthermore, Dr. Bozzo has only estimated 10 of the previously estimated 25 variabilities that Dr. Bradley estimated. In addition there are a large number of MODS and non-MODS variabilities which have not yet been estimated. Finally, there are significant methodological issues in dispute over the work.

Accordingly, it is important that volume variability issues be thoroughly and additionally explored before being adopted by the Commission. The current estimators appear to be tentative. As can be seen from Table 1, the proposed variabilities have actually changed over the short course of several years, apparently due to changes in data scrubbing and methodological changes.

I recognize that the tone of my testimony is negative, as related to both the testimony of Dr. Bradley and the follow-on work of Dr. Bozzo. Although it would have been satisfying to present new econometric methodologies and economic theories carried to their ultimate conclusions, I have found that such an accomplishment is not possible within a four month time frame--particularly since such an effort would apparently require in excess of five person years of work. Accordingly, I am recommending to the Commission the following approach to a resolution of the volume variability issues.

C. The Commission Should Recommend Establishment of a Working Group to Resolve the Mail Processing Issues.

The resolution of the volume variability issue has major cost allocation implications, and extensions and improvements to the work appear likely to require a significant amount of additional effort. That effort can best be accomplished in the atmosphere of a working group in which technical issues can be discussed and resolved in a non-adversarial atmosphere. In this way, I believe many of the more technical issues regarding the handling of the data and variables and the estimators could be substantially narrowed. Accordingly, the Commission may wish to consider recommending that the Postal Service establish an ongoing working group of interested intervernors and other interested groups for the review, analysis, and conclusion of the study.

VI. DR. BOZZO'S METHODOLOGY IS EVALUATED UNDER ESTABLISHED CRITERIA

I have listed, above, the several deficiencies that I conclude are present in the USPS modeling of mail processing variabilities. Standing alone, without placing them in the context of an overall evaluation of the methodology in a structured way, it may be difficult for the Commission to weigh the relative significance of individual issues in a laundry list of problems in the context of a full-blown analysis. That is, certain issues may appear to be concerned with minutia, of little overall significance to the resolution of the problem. As the Commission has stated, "The blueprint for a successful application of econometrics is well-understood...."[23] An econometric study is judged by whether it successfully meets generally established criteria. I am therefore presenting my testimony in a format discussing five important criteria similar to that which the Commission recognized as appropriate for evaluating econometric methodology. In measuring Dr. Bozzo's study against these criteria, I have found the study deficient in important respects in each of the areas. The following sections present an evaluation of Dr. Bozzo's work in terms of the criteria discussed in Appendix F of the Commission's opinion in Docket No. R97-1.

[23] Docket No. R97-1, *Opinion and Recommended Decision,* Volume 2, Appendix F at 1.

A. Criterion 1: A Study Should Include the Development and Use of an Adequate Database, Appropriately Verified and Complete.

1. The database was not adequately examined and verified for accuracy.

A review of the data scrubbing issues associated with Dr. Bradley's work provides some insight into the inadequacy of the underlying databases for both studies. The Commission concluded that the scrubs were excessive because they eliminated usable data and ineffective because the rules applied in the scrubs did not reliably identify erroneous observations. The Commission concluded that the scrubs produced a selection bias by unduly affecting the estimated variabilities.[24] The Commission indicated that, "It is the Commission's understanding that good econometric practice requires that when data are removed from a sample, they are removed because the econometrician has investigated and found good cause for believing that the data are erroneous."[25]

Dr. Bradley's initial data review appears to have been based on the application of statistical analysis. The differences between Dr. Bradley's data set and the data set used in the current study are actually quite minor. Quarterly data are used in the current study in lieu of four week accounting period data in order to smooth out inaccuracies; the rejection criteria are relaxed; and the overall time period is changed due to a major data discontinuity at the time of the Postal reorganization.

[24] *Id. at* 31.

[25] *Id. at* 28.

The underlying data bases from which Dr. Bradley obtained the data for the study are unreliable. As the Commission indicated, "Even without the report of the Inspection Service, a conscientious examination of the data sets would disclose unmistakable internal evidence of serious errors."[26] The data set used in the current study apparently continues to be drawn from the same data source and appears to have been initially subjected to minimal actual field verification. Field level data verification appears to be required to provide a sound basis for the analysis. Several of Dr. Bozzo's responses to interrogatories appear to focus on data checking "after the fact." One response discussed data errors due to commingling of manual and SPBS parcels, and a gap in the manual priority volume reporting at a site.[27] The response also discussed data questions related to 13 sites, largely involving reclassifications of facilities or the introduction of new facilities. This is the type of data verification that should be performed prior to beginning the analysis.

In view of the known deficiencies of the MODS data base, as well as the changing nature of the data as verified by questions raised in interrogatories, I conclude that the database should have been subjected to substantial field verification for accuracy and completeness. Such verification could be performed initially on a sampling basis to verify the degree of accuracy. Follow-up efforts would involve contact with the people responsible for data collection to determine data accuracy as well as to gather information on site specific circumstances. The actual examination and

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[26] *Id. at* 26.

[27] UPS/USPS-T15-13, Tr. 15/6387-8.

verification of data from sites with input from field personnel does not appear to have been performed to any significant degree.

Statistical data scrubbing is not an adequate substitute for on-site data verification. A proper approach to the verification of data is to select a sample of data items and perform a field check to determine reliability. Procedures must then be implemented to upgrade the data set if the data prove to be unreliable.

In performing the data review, there was no discussion of the possible segmentation of the database into subsets of similar sites to facilitate accurate comparisons. Clusters of sites could have been considered by size, degree of technology and automation (thereby avoiding the meaningless manual ratio), the clustering of processing activities, and probably other classifications. By grouping similar sites, much of the fixed effects problem identified by the Commission could be avoided. A smaller number of sites based on clustering might produce less precise statistical estimates; however, the tradeoff might be increased accuracy.

An example of the importance of the data issue was provided in an interrogatory response that indicated there were large upward revisions to the manual parcel and priority variabilities due largely to the application of tighter sample selection rules.[28] It is reasonable to conclude that the study is deficient in terms of its underlying database, and that the conclusions may be tentative, depending significantly on data scrubbing.

[28] AAP/USPS-T15-5, Tr. 15/6227.

2. Changes in postal investment subjected the investment data trends to changes during 1994-96; previous data may be unrepresentative of operating conditions in the forthcoming rate effective time period.

The history of Postal Service investments in mail processing equipment is summarized in Table 3 and the accompanying graph.[29] Table 3 indicates that the Postal Service's investment in mail processing equipment changed during 1994-1996. It remained, on average, at a level much higher than the level of investment in the three previous years, 1993 through 1995. Thus, the investment expenditures in the early years included in Dr. Bozzo's study differ significantly from the investment expenditures for the later years. Moreover, plans for future Postal Service investments are delineated in the annual investment capital plans,[30] and the Postal Service continues to project a high level of investment in mail processing equipment. It therefore appears that part of the data relied upon by Dr. Bozzo is not representative of the period for which the rates will be in effect. According to Dr. Bozzo, the potential impact of unrepresentative data is important:

> My main motivation for employing data over a shorter time period was the desire to balance the potentially competing aims of efficient estimation and accurate estimation of the labor demand functions....However, extending the sample period back in time does not hold other things equal. It raises the possibility of introducing non-sampling errors in the estimates to the extent the earlier data are unrepresentative of current operations."[31]

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29 ANM/USPS-T9-47-49, Tr. 2/199-202.

30 ANM/USPS-T10-17, Tr. 2/408.

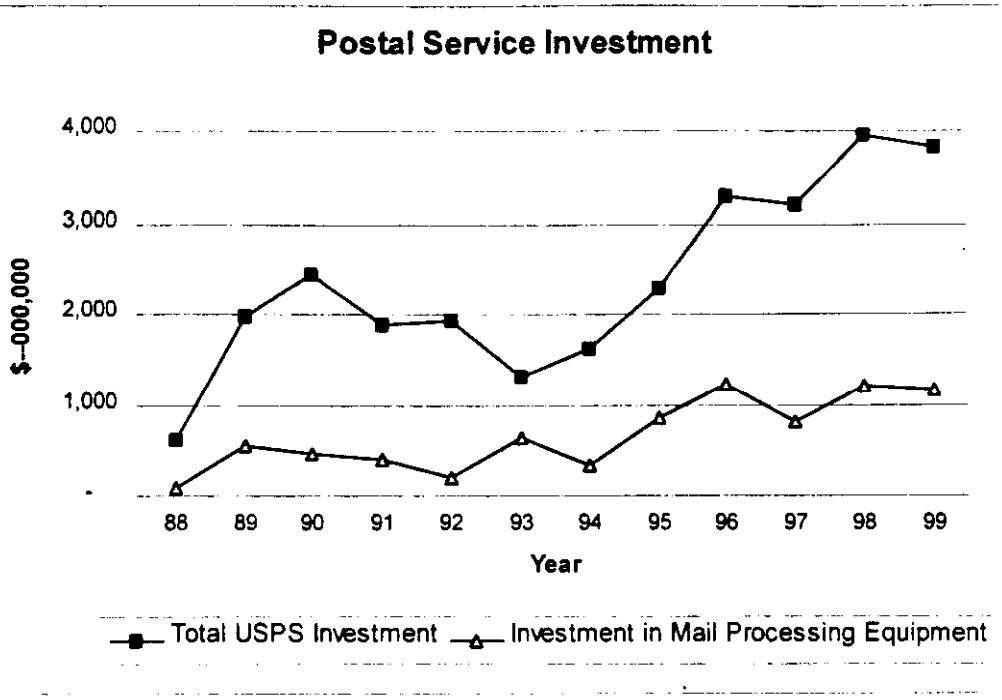
31 OCA/USPS-T15-6, Tr. 15/6298.

Fluctuations in the investment data may make them unrepresentative for purposes of analysis. The investment data will impact the values for capital, possibly making earlier data irrelevant to current practices. The investment data are plotted in the following graph derived from Table 3.

Table 3
Postal Service Investment--1988-1999

Year	Total Postal Service Investment $--000,000	Mail Processing Equipment Investment $--000,000
88	623.9	91.9
89	1,987.5	560.0
90	2,436.4	466.4
91	1,883.1	397.7
92	1,924.8	201.1
93	1,309.6	634.5
94	1,635.5	326.9
95	2,284.9	866.8
96	3,306.9	1,220.5
97	3,202.6	808.2
98	3,947.0	1,204.1
99	3,817.3	1,158.1

Source: ANM/USPS-T9-47-49, Attachment



Accordingly, in examining the Hours/TPF relationships, Dr. Bozzo has an underlying investment series that may be unrepresentative of current operations. The changing nature of segment 3 data for segment 3 hours and total mail is shown on an aggregate basis in Table 4 in terms of payroll hours for segment 3 and total mail. There was a major change in trend in the 1997 time frame. Dr. Bradley treated a similar discontinuity with a dummy variable, but Dr. Bozzo has not addressed the impact on his conclusions of the changing trends.

Table 4
Mail Volume and Segment 3 Hours

Year	Volume Total All Mail	Cost Segment 3 Payroll Hours Work (Clerks & Mailhandlers)
1999	201,576,279	694,845,627
1998	196,904,690	694,686,240
1997	190,888,059	693,945,735
1996	183,439,474	680,293,834
1995	179,932,615	667,448,113
1994	177,177,362	654,575,064
1993	170,312,972	617,449,610
1992	165,654,138	615,041,369
1991	165,057,806	631,555,134
1990	165,502,505	633,771,319
1989	161,603,263	641,645,471
1988	160,953,625	638,779,872
1987	153,152,758	626,078,466
1986	146,578,077	603,546,949
1985	140,097,956	582,351,682
1984	131,544,622	560,064,472
1983	118,476,588	524,770,256
1982	113,121,664	518,265,011
1981	110,130,400	525,640,282
1980	116,451,141	528,221,756
1979	99,828,883	527,506,828
1978	96,913,154	517,087,887

3. The continued use of the manual ratio is undesirable.

Dr. Bozzo continues to use the manual ratio as a measure of the degree of automation. Recognizing that the manual ratio can be affected by volume, he nevertheless maintains that the mail processing technology rather than mail volumes determine the manual ratio.[32] He maintains that a computed manual ratio number is comparable from site to site, even though the size of the sites may range from small to

[32] USPS-T15 at 24, line 11.

large.[33] However, he also admits that to the extent network characteristics affect local mail flows and automation usage, they may affect the manual ratio variable.[34] Finally, he appears to believe that the size of the mail processing facility as measured in TPF would not affect the manual ratio, *other things equal,* but since the TPF are likely to be related to network characteristics one would expect that other things are not, in fact, equal.[35]

In my view, use of the manual ratio in the analysis is inappropriate. Other measures of the degree of automation for an activity need to be developed; for example, the capacity and numbers of machines for an activity at a site could be used as a measurement of automation capability.

4. The QICAP variable has not been demonstrated as appropriate.

(a) The presentation of the variable QICAP, used to measure capital usage at each facility, is inadequate.

The regression equations, as outlined on pages 117 and 118 of Dr. Bozzo's testimony, use a variable denoted as "CAP". Apparently, this is the QICAP variable referenced in LR-I-107.[36] QICAP is denoted as a quantity index for facility capital. The value of the capital items at a facility are depreciated, adjusted for inflation, and transformed into a capital flow. The details of the procedure were apparently presented

[33] OCA/USPS-T15-8, Tr. 15/6301.

[34] OCA/USPS-T15-11, Tr. 15/6305.

[35] OCA/USPS-T15-15, Tr. 15/6309.

[36] USPS-LR-I-107, Docket No. R2000-1.

in the previous case.[37] The derivation of QICAP was discussed during an informal technical conference with Dr. Bozzo and was also the subject of interrogatories. However, the presentation of the derivation of QICAP is inadequate; QICAP is not even discussed in Dr. Bozzo's testimony, and it is impossible to determine the relevance of previously presented information to the current use of QICAP. There are a number of deficiencies associated with the QICAP variable.

(b) The variable QICAP appears to be deficient from a computational viewpoint.

The use of the variable QICAP in a regression equation might yield spurious results. Dr. Bozzo indicates that the QICAP numbers are not strictly additive from site to site.[38] He indicates that they are approximately additive, but that additional computations need to be made. Accordingly, Dr. Bozzo has not demonstrated that QICAP is a cardinal number although on a practical basis it may be possible to perform sufficient computations to adjust the number for adequacy under certain circumstances. Regression equations are based on the addition and multiplication of numbers in the matrices that define the regression equation. Numbers that yield inaccurate results when added or multiplied may result in the wrong conclusions.[39] Accordingly, there may be a mathematical problem in using QICAP in a regression equation.

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[37] USPS-LR-H-272, Docket No. R97-1.

[38] OCA/USPS-T15-45, Tr. 15/6341-2.

[39] A very simple example will illustrate this: if the price of food rises by 3percent and the price of clothing rises by 2 percent, then prices are not up by 5 percent.

(c) QICAP is available on a facility basis, not on an activity level basis; this may lead to meaningless results when including capital investment in the study.

The variable QICAP is available only on a facility basis. QICAP is a measure of the capital used at a facility rather than for an activity. For example, at a site with various types of automated or mechanized operations (*e.g.*, cancellation, bar code sorters, optical character readers) and manual operations (*e.g.*, manual sorting of parcels or letters), only one number is available: the overall amount of capital used at the facility. Furthermore, capital used in activities that are not even being modeled is also included in QICAP as long as the capital is present at the facility. Accordingly, the modeling of any activity at a facility is based on the overall usage of capital at the facility, regardless of whether the particular activity is capital intensive or uses capital minimally.

Dr. Bozzo essentially maintains that the QICAP variable in its current state is the best estimate of capital usage available. He maintains that it is not possible to classify all equipment at a site by cost pool. According to Dr. Bozzo, the resulting cost pool level capital measures which would result from segmenting available data by activity cost pool would not represent the cost pools of capital *per se,* but rather, they would represent the portion of the cost pools capital that could be associated with the cost pool using the Property Code Number (PCN). He further notes that data on facility space, which he alleges to be an important non-equipment component of a hypothetical

cost pool capital index, are not available by cost pool.[40] He further maintains that it is not obvious that a cost-pool-level capital measure would be the sole--or even the primary economically relevant measure of capital. He has indicated that, in his view, the effect of including the facility capital index is to capture the fixed effect on labor demand in a given cost pool of the capital services employed in that cost pool as well as the capital services employed in other pools.

An example illustrates the deficiency of QICAP. Witness Kingsley has discussed the installation of Flat Sorting Machines in detail. Such machines will provide a higher level of automation than currently exists. Apparently machines of significantly less capital value, sophistication, and capability are currently in use at the mail processing facilities. Based on Mr. Degen's and Ms. Kingsley's testimonies, it is clear that most major mail processing facilities have sophisticated, high capability Optical Character Reader (OCR) and Bar Code Sorter (BCS) machines. Accordingly, in any analysis of FSM's at a given site, the QICAP variable appears likely to reflect to a disproportionate degree the investments in OCR and BCS machines. In analyzing the flat sorting activity, one would be using a value for capital strongly influenced by other activities.

A further example demonstrates a potentially greater mismatch, if instead of considering flat sorting machines, one considers the manual casing of mail. Regardless of how sophisticated the automated activities of the plant are, it does not appear that

[40] Although square feet of space clearly cost money, Dr. Bozzo has not explained how the associated space affects hours of labor.

this investment will have much impact on the manual casing of letters, a technology in existence for many years.

(d) Some of Dr. Bozzo's computations illustrate the dubious nature of the variable QICAP.

Turning to Table 6 of Dr. Bozzo's testimony,[41] one can compare the capital elasticity of manual flats and manual letters with that of a bar code sorter. The capital elasticities for the manual operations are greater than the capital elasticities for the OCR. The conclusions that one could draw from Table 6 do not comport with reality, and there is inadequate discussion of the results. At the very least, some extensive discussion of the results should be provided. For purposes of analysis, it appears that capital data are needed at the activity level if activities are to be analyzed. A statement that such data are not available does not suffice as a reason for its non-inclusion.

(e) The approach to equipment depreciation and the failure to consider maintenance efforts also renders QICAP meaningless.

The Postal Service depreciation rates, by equipment category, are as follows: mail processing equipment, 8.3 percent per year; postal support equipment, 11.5 percent per year; and buildings, 2.33 percent per year.[42] QICAP is used as a measure of capital for mail processing machines. Dr. Bozzo asserts that from an economic viewpoint the machines have useful value consistent with the geometric perpetual

[41] USPS-T-15 at 119.

[42] OCA/USPS-T15-47, Tr. 15/6344-5.

inventory equation.[43] Dr. Bozzo has justified the accelerated depreciation rate as being based on internal Postal Service studies; however, these are internal studies based on previous, historical experience. The modern equipment that is currently being installed may be quite different from that installed previously, rendering the historical depreciation rates meaningless. In addition, the depreciation rates being used appear to be based on accounting data rather than operational reality: it is difficult to imagine that an FSM is 8.3 percent less productive after its first year on the job.

In an industrial setting, various vintages of the same machine may be present on the factory floor. Regardless of the level of depreciation accrued by the accountants, the machines will typically have the same level of productivity when operating. The major difference (if any) between the machines is that the older machines may require increased maintenance. From the viewpoint of activities in factories, there will usually be a relationship between hours of operation and levels of maintenance based on the age (*i.e.*, depreciation) of the machinery after a few years. Older machines will maintain their operability as they depreciate through increased maintenance. Accordingly, in comparing vintages of capital it is necessary simultaneously to consider maintenance: maintenance hours, operating hours, and capital equipment are strongly interrelated.

However, no management or maintenance time is included as a variable in the regression analysis.[44] Even assuming QICAP is correct from a depreciation point of view, one would need to note that operating and maintenance labor is carried in

[43] OCA/USPS-T15-49, Tr. 15/6349.

[44] OCA/USPS-T15-63, Tr. 15/6376.

another account but is a complement to machine operating time. Accordingly, the study is seriously deficient without consideration of management and maintenance hours.

5. Capacity utilization is another potentially important variable missing from Dr. Bozzo's database.

It is well known that the output, efficiency, and resource requirements of factory operations are strongly related to capacity utilization. For example, it is common knowledge that investors, economists, and the financial press examine factory capacity utilization as a signal of price, employment, and other economic changes. For an industrial style process, capacity utilization is a key number.[45] Dr. Bozzo's study has no measure of capacity utilization, and this is a potentially serious deficiency. Furthermore, there is no reason to believe that TPF or TPH are approximations of capacity utilization. Dr. Bozzo treats them as an output, so while they may be correlated with capacity under certain circumstances, they do not measure capacity. It should also be obvious that capacity utilization is not measured as a fixed effect. Accordingly, the lack of a capacity utilization variable is a major deficiency of the model.

6. In conclusion, there are serious data problems underlying the foundation of the study.

The data problems associated with the current study include data scrubbing/non verification, problems with specific variables (QICAP, manual ratio), the potentially unrepresentative nature of the data series, and issues associated with omitted

[45] If capacity utilization were at 100 percent, it would still be possible to increase production in the short run through extraordinary measures, and in the longer run through the addition of machines and/or plants.

variables. Dr. Bozzo's database does not appear to meet the standards of reliability. Finally, a potentially key variable, capacity utilization, is missing.

B. Criterion 2: Models Should Be Derived from the Appropriate Economic Theory and Should Fit Correctly Within any System that Applies Them.

1. The economic assumptions and theory for the current study are not clear; in many cases they appear to be wrong.

Both Dr. Bradley and Dr. Bozzo used translog functions to estimate the relationship of labor hours and TPF or TPH. Dr. Bozzo indicated that "....I find that Dr. Bradley's lack of stated cost theoretic underpinnings for his mail processing study added unnecessary confusion to the Docket."[46] A similar statement also applies to the work that Dr. Bozzo has presented. The econometric testimony in this proceeding is replete with references to advanced microeconomic price theory. However, the underlying microeconomics are interspersed throughout the presentation. Accordingly, it is difficult to follow the logical progression of the derivation, properties, and logic of the analysis and the functions being estimated.

On a preliminary basis I have identified the following problems, which will be considered in the following sections:

- Statement of the function being estimated;
- Selection of variables to be estimated;
- Treatment of Network issues;
- Variables: Manual Ratio and QICAP;

[46] USPS-T-15 at 44, lines 18-20.

- Time Frame: Short run and long run; and
- Cost minimization

2. Dr. Bozzo and Dr. Bradley do not agree on the type of function being estimated; much improvement in the presentation of the labor demand function is needed.

Dr. Bradley estimated the relationship of hours and TPH, which he denoted as a cost function. Dr. Bozzo defines the relationship as a labor demand function. Both economists are estimating what is essentially the same function. The function obviously cannot be both a cost function and a labor demand function. This confusion highlights the absence of a clear economic exposition of economic theory and assumptions.

Dr. Bozzo indicates that his labor demand function is actually a conditional labor demand function that can be derived from a partial equilibrium model of cost minimization or from a generalized non-cost minimization model. However, he performs neither derivation, and the reader and ultimately the Commission are left with the problem of constructing the theories underlying his testimony. [47]

The Commission's comment in discussing Dr. Bradley's cost function is again applicable. The Commission said that, "Given the arbitrary nature of witness Bradley's cost equation, the Commission's criticism in Docket No. R87-1 that 'an imaginative analyst can obtain almost any desired variability estimate by carefully choosing the variables and the time period to be used in the analysis' seems to apply."[48] Dr. Bozzo's

[47] OCA/USPS-T-15-56, Tr. 15/6358-9.

[48] Docket No. R97-1, *Appendices to Opinion and Recommended Decision,* Volume 2, at 8.

conditional labor demand function is open to similar criticism. First, a labor demand function is defined as $x_j=x_j(w_1, w_2..w_n, p)$ for $j = 1...n$. For estimating purposes, appropriate derivations from the production function would yield an estimating equation, specified in terms of the production function variables. As indicated by Dr. Bozzo, the mathematical relationship between the cost function and labor demand function, known as Shepard's lemma, provides that if the cost function is locally differentiable, the labor demand function is equal to the partial derivative of the cost function with respect to the wage.[49] It is possible that the Postal Service operates under conditions in which Shephard's lemma does not apply. Dr. Bozzo responded to a question about "cases of non-equilibrium" conditions under which his theory is substantiated:

> To the extent that the term refers to situations under which the relevant theoretical conditions of the cost minimizing (or generalized non-cost minimizing) model do not hold, my results would still represent an empirical analysis of the Postal Service's demand for labor in mail processing operations, but the mathematical relationship ("Shepard's lemma") between the labor demand and cost functions would not necessarily hold.[50]

Dr. Bozzo did not fully explain the applicability of his labor demand function. Dr. Bozzo has also indicated that he included variables to bridge the gap between generic theory and operational reality. He indicated that the labor demand models used, and the cost functions implicitly associated with them, employ additional variables for that reason.[51] In order to verify that Dr. Bozzo's approach is grounded in economic theory,

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[49] OCA/USPS-T-15-17, Tr. 15/6311-2.

[50] OCA/USPS-T-15-59(a), Tr. 15/6365-6.

[51] OCA/USPS-T-15-56(c), Tr. 15/6358-9.

the Commission needs an explicit derivation of the labor demand function, an additional analysis of the endogenous or exogenous nature of investment, and a discussion of the impact on labor demand under conditions of monopsony, monopoly, and imperfect competition. This would alleviate concerns about variables in the equations and whether additional equations were needed, particularly in view of Dr. Bozzo's comments about exogenous and endogenous variables.

3. Dr. Bozzo's study is short run. The proper approach for examining postal facilities is on a longer-run basis as related to major investment plans and movement along the facility expansion path.

The concepts of the short run and the long run are clear from the viewpoint of theoretical economics. In the *short run* some of the factors of production (for example, labor) are variable. In the *long run*, all of the factors of production are variable. Postal Service investments in capital to reduce operating costs indicate a long run approach is applicable to the analysis. Instead of measuring the short run relationship between labor and volume, the appropriate relationship to measure is the movement along the expansion path that occurs when the Postal Service invests in new plant and equipment. This focus on the expansion path reflects changes in the scale of the facility as incremental labor or incremental capital are added.

In Docket No. R97-1, I advocated that a pooled equation could measure the longer-run expansion path. However, it has become increasingly clear that the labor hour/TPF data points gathered based on field data probably measure mail processing at a variety of disequilibrium points, based on varying capacity utilization and varying levels of mail. Accordingly, in a subsequent section I advocate that the regression

analysis at this time should be performed on data means rather than on the larger data set of individual observations that would be used in the pooled case. This is probably the "least bad" approach, even though various statistical deficiencies have been noted.

Dr. Bozzo states that, "Since capital is treated as a quasi-fixed factor, I am estimating 'short run' functions."[52] Dr. Bozzo's approach is wrong; there is a need to measure longer-run functions. He is only measuring transitory changes in mail processing.

The Postal Service witnesses and management appear to have a time frame of as little as one year to as much as five years in mind when they discuss the longer run, the period over which capital investment varies. The time frame seems to center on the two to three year range.

Dr. Bozzo recognizes that there are short-run and longer-run aspects of clerk and mail handler labor mail processing demands and that labor can fluctuate in the short run:

> My review of witness Moden's testimony (Docket No. R97-1, USPS-T-4) and discussions with Postal Service operations experts revealed that there are two main staffing processes. One process assigns the existing complement to various operations to meet immediate processing needs, and operates on time scales on the order of hours (let alone eight weeks). However, the longer term process of adjusting the clerk and mail handler complement operates more slowly--our operational discussions suggested up to a year.[53]

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52 OCA/USPS-T15-61, Tr. 15/6373.

53 USPS-T-15 at 18, lines 6-13.

In conclusion, it would appear that there are several time periods relevant to the estimation of postal costs. One time period is a day, the period over which very short-term adjustments to labor are made on an operational basis. A second time frame appears to be the 4 week or 3 month time frame used by Dr. Bradley and Dr. Bozzo. Both of these time frames have little relevance to the longer-run expansion plans that seem to drive mail processing costs, have little relevance without information on capacity utilization, and may represent unreliable data readings for plants operating in a mode that is significantly different from equilibrium.[54] Finally, a longer-run time period, which would appear to approximate the length of the rate effective time period in the neighborhood of two years, seems to be the time frame over which investment, personnel, and equipment decisions are realized. Given the increasing importance of capital investment decisions to the Postal Service, this would appear to be the relevant time frame.

Mr. Degen also recognizes the ongoing length of the investment process: "From initial proposal to project completion, it may take anywhere from 6 to 9 years to bring a new plant on line. Site acquisition, planning, and approval for a new plant can easily take 5-7 years and actual construction another 1-2 years."[55] Apparently the Postal Service sites new plants to adjust to the network on a continuing basis, in recognition of increasing Postal flows. Accordingly, the actual longer-run time frame in which an

[54] Apparently, the set of mail-processing plants is under continuous modifications as plants are added, subtracted, and modified in the network. In some cases, the data generated by the plants may be of a transitory nature and irrelevant to the analysis.

[55] USPS-T-16, at 15, lines 4--7.

investment decision is made and implemented after a relatively protracted planning framework appears to be in the neighborhood of two years. Dr. Bozzo has also recognized that investment is an ongoing process, indicating that major equipment deployments usually take more than one year.[56]

It appears that a longer term model would best be approximated by a cross sectional analysis as modeled by the "between" model, based on Mr. Degen's testimony as outlined in his Figure 3.

4. Dr. Bozzo addressed Dr. Bradley's omission of variables in the regression equations. Dr. Bozzo considers additional variables, but the consideration is still deficient.

Dr. Bozzo indicated that:

> Since the additional explanatory variables--particularly wages and network variables--are statistically significant, my results indicate that Dr. Bradley's Docket No. R97-1 mail processing models for the operations I studied were under specified. As a result, Dr. Bradley's results appear to exhibit omitted-variables biases to some degree. However, since the revised variabilities accounting for these factors are lower, contrary to the expectations set forth in the Commission's Docket No. R97-1 analysis, the direction of the omitted variables biases in Dr. Bradley's results were mainly upwards, not downwards.[57]

The problem of which variables are to be included in a regression equation is a major problem in applied econometrics. I am concerned that the work presented is still lacking in important variables: a measurement of capacity utilization, specific capital measurements relating to activities rather than facilities, capital measurements that are additive, and possibly other variables. The analysis of network effects, and the

[56] OCA/USPS-T15-13, Tr. 15/6307.

[57] USPS-T-15 at 127, lines 10-17.

variables considered, is also, in my opinion, deficient; this is discussed in another section of my testimony.

5. The newly presented information about networks needs to be fully incorporated in the analysis.

There are repeated references to mail processing networks in both Dr. Bozzo's and Mr. Degen's testimonies. Although networks have not been previously referenced in regards to segment 3 mail-processing costs, the concept of the network has been in the literature in at least some form since at least 1986.[58] Mail processing activities and sites do not stand alone in terms of the network of originating and destination nodes. There seem to be three types of network issues. First, there is the intra-plant network of activities that feed mail to each other. One gets the impression that this network could change based on a variety of factors, including network volumes. A second type of network effect is apparently the delivery configuration of the service territory. Dr. Bozzo measures this network configuration with a variable measuring the number of possible deliveries. Finally, the position of the plant in the mail flow between other mail processing plants also seems to be a type of network relationship. According to an interrogatory response, the size of facilities and their mail processing operations depends not only on the volume of mail processed, but also their position in the Postal Service's network.[59]

[58] Laurits R. Christensen Associates, *United States Postal Service Quarterly Real Output, Input, and Total Factor Productivity, 1982 Quarter 1 Through 1986 Quarter 1, March 1986*; "A Report to Charles Guy, Director, Office of Economics, United States Postal Service," in USPS-LR-H-272, Docket No. R97-1.

[59] USPS-T-15 at 26, lines 4-6.

The analysis conducted by Dr. Bozzo addressed only the possible deliveries; he did not address the networking of activities at the plant level or the interchange of mail between plants. Both of these types of network effects might have an impact on labor demand.[60] These factors, often in conjunction with volumes, appear to determine the length of processing windows, the complexity of mail processing schemes, the relative amount of labor required for set up and take down activities, the operation's role as a gateway or backstop, other indicators of the level of costs, and the degree of volume variability. Accordingly, both Mr. Degen and Dr. Bozzo have introduced an important concept. The Commission has not reviewed networks in the recent past in evaluating Dr. Bradley's testimony, and this concept, which is new to the segment 3 analysis, does not appear to have been developed adequately.

6. Dr. Bozzo estimates mail processing activities (*e.g.*, manual processing, OCR, BCS) as independent activities; based on witness Degen's comments on networks and facilities, serious consideration needs to be given to the simultaneous modeling of activities.

Dr. Bozzo's approach is focused on single activities at a time: he treats the mail-processing activities as separable. However, mail-processing activities are not performed alone; this is partly recognized by Dr. Bozzo in his discussion of capital investment. Based on my experience with batch production processes I would expect that the operation of one mail processing activity is not independent of another. Dr.

[60] USPS-T-15 at 47.

Bozzo referenced *Freight Transportation Regulation* by Friedlaender and Spady.[61] They advocate the specification of a cost function in terms of multiple outputs. When asked if he considered such an approach in his estimation efforts, Dr. Bozzo indicated, "Yes. First, to characterize the set of operations for which I report econometric results, I employ ten equations with ten output (piece handling) variables; additionally, each equation includes other non-volume 'cost drivers' in addition to piece handlings. Second, my analysis is an element of the Postal Service's 'distribution key'."[62] Dr. Bozzo apparently considered the operation of each activity as being separable from another. However, Friedlaender and Spady seem to advocate simultaneous consideration of activities.

The relationship of processing patterns, volumes of mail, and the interaction of activities appears to be inadequately addressed in Dr. Bozzo's analysis. During oral cross-examination, Dr. Bozzo acknowledged that the mix of activities in operation at a site has an impact on the hours per TPF relationship.[63] He maintained that the use of the manual ratio captured the effect. Although the use of the manual ratio as a measure of the degree of automation is subject to serious criticism, there is no clear (or possibly even existing) relationship between the manual ratio and the activities at a site. The issue requires additional exploration.

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[61] Ann F. Friedlaender, Richard H. Spady, *Freight Transport Regulation*, Cambridge, MIT Press, 1981.

[62] OCA/USPS-T15-61(e), Tr. 15/6373-4.

[63] Tr. 15/6417.

7. Dr. Bozzo's treatment of homotheticity appears to lead to incorrect conclusions.

In his testimony Dr. Bozzo asserts that "...capital and labor variabilities will be identical, in equilibrium, under the assumption that the cost-pool-level production (or cost) functions are *'homothetic'*...Homotheticity implies that changing the level of output of the operation will not alter relative factor demands such as the capital/labor ratio, in equilibrium (and other things equal)."[64] However, the Postal Service testimony is replete with examples of the implementation of major investment programs designed to reduce costs. This concept was further developed in the Postmaster General's recent speech in Nashville.[65] The focus is on the elimination of major labor costs via capital investment to achieve an overall reduction of total costs. Accordingly, the application of a homotheticity assumption appears to be an inappropriate assumption.

8. Dr. Bozzo has raised some important issues about cost minimization; resolution of the issues may affect the cost segment 3 analysis.

Dr. Bozzo has stated that his theory is independent of whether the Postal facilities minimize costs and, in support, cites a publication by Toda.[66] Dr. Bozzo's testimony does not discuss QICAP and he has provided only a limited amount of useful information in this proceeding on the development of the variable QICAP. Accordingly, I

64 USPS-T-15 at 40, lines 10-14.

65 Prepared remarks at the National Postal Forum, Nashville, Tennessee, March 20, 2000, See OCA/USPS-98, Tr. 21/9152.

66 The article introduced by Dr. Bozzo on the topic of non cost minimization appears to be by Yasushi Toda, "ESTIMATION OF A COST FUNCTION WHEN THE COST IS NOT MINIMUM: THE CASE OF SOVIET MANUFACTURING INDUSTRIES, 1958-1971," *The Review of Economics and Statistics*, Vol. LVIII, August 1976, 259-268.

have relied on the library reference that he has mentioned.[67] The documents referencing QICAP are filled with references to Total Factor Productivity. Toda's article shows that measurements of Total Factor Productivity may be incorrect when computed for non-cost minimizing firms. Dr. Bozzo indicates that his measurement of QICAP does not depend on a measurement of Total Factor Productivity (which the Postal Service appears to use in other circumstances). It is not clear what the impact of the Toda article would be; however, this is an issue that needs to be reviewed.

In reviewing the associated library reference, two potential deficiencies associated with QICAP were found:

(1) Depreciation reported in the National Consolidated Trial Balance is an inappropriate measure of the value of owned capital. To be specific, the depreciation reported in the NCTB is based on accounting period conventions not suitable for productivity accounts.[68]

(2) The Moody's composite of average yields on corporate bonds is used in arriving at the USPS cost of capital.[69] OCA witness Dr. Edwin Rosenberg (OCA-T-3) has indicated that the Postal Service can borrow from the U.S. Treasury at the cost of money plus 1/8 percent.[70]

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67 USPS-LR-H-272.

68 USPS-LR-H-272, "USPS Quarterly Total Factor Productivity Methodology, A Report to Charles Guy, Director, Office of Economics, USPS," L.R. Christensen Associates, January 1988.

69 *Ibid.* at 47.

70 OCA-T-3, Docket No. R2000-1.

In discussing Postal Service cost minimization, one is addressing certain operating procedures from the point of view of economic theory. The Postal Service approach to operations and pricing in terms of whether or not it maximizes its output can result in a very different situation than one in which efficient competitive equilibrium is sought.

From classical economic theory, an output maximizing company (in comparison to a profit maximizing/cost minimizing company) does not operate efficiently, achieving the equality of marginal cost with demand under different conditions than would occur under pure competition. Dr. William Niskannen's pioneering work on public organizations provided the microeconomic theory for an enterprise charged with public responsiveness and responsibilities.[71] He indicated that such an organization has a tendency to over-invest. It is interesting to note that a refrain in the Postal Service community is the need to grow volume and increase investment.

The benchmarking of corporate practices has been a major goal in the corporate sector in recent years as companies have attempted to become increasingly efficient. Witness Tayman, in commenting on investment policies, indicated that he was unaware of any benchmarking studies on investment standards relating to equipment in place.[72] Also, when requested, the Postal Service was unable to produce any internal documents prepared by or for the Postal Service evaluating the level of capital spending by its counterparts, either in other advanced industrial nations or by its major

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71 Niskannen, William A., *Bureaucracy and Representative Government*, Chicago, Aldine, 1971.

72 Tr. 2/500-1.

competitors in the United States, such as FedEx or UPS. Moreover, Postal Service witness Kingsley has stated that there are no studies produced by or for the Postal Service since the beginning of 1998 evaluating its flat processing automation as compared to the automation achieved by its counterparts in other advanced industrial nations.[73] These responses tend to confirm that there are no benchmarking studies.

In a response to the interrogatory of the Association of American Publishers (AAP), the USPS recites Professor Panzar's direct testimony in Docket No. R97-1:

> However, the efficiency of the Postal Service operating plan is not an issue for the analyst. As long as it is given that postal services will be produced following Postal Service practices and procedures, the relevant marginal and incremental costs for pricing purposes are those calculated based on the Postal Service operating plan.[74]

It is clear that, on occasion, the USPS does not achieve its investment budget (apparently failing to meet plans) and has very limited, if any, analyses verifying whether such an investment budget is efficient. Accordingly, Toda's comments, introduced to this proceeding by Dr. Bozzo, are relevant. The behavior of a cost function that is not based on the theoretical assumptions of cost minimization and marginal productivity pricing is apparently a very different assumption from the cost minimization case. The impact on Dr. Bozzo's conclusions needs further explanation.

Toda's work was developed for the analysis of the Soviet economy. Soviet businesses appear to have been operated under an output-maximizing objective. In addition, the industries were under various governmental regulations in acquiring the

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[73] ANM/USPS-T10-27, Tr. 5/1578.

[74] AAP/USPS-1, Tr. 21/8611.

factors of production, and the prices of finished goods and intermediate products were not set on a shadow price basis. Accordingly, a mixture of operating inefficiencies and improper pricing could theoretically arrive at a situation different from that obtained from an efficient competitive equilibrium.[75]

The Postal Service is a major purchaser of goods and services, and possibly even has some degree of monopsonistic power in the purchase of some types of specialized machinery as well as monopolistic competitive power in the sale of certain services. Therefore, Postal Service may, through its resource input, production, and operating decisions, affect factor prices. Accordingly, in achieving an economically inefficient factor allocation, the USPS may make purchasing and investment decisions that result in the distortion of factor prices, resulting in the generation of factor input prices different from those that would normally occur in a competitive environment. Dr. Bozzo did not address the implications for the labor demand function.

9. In conclusion, the theory underlying Dr. Bozzo's model has not been shown to be derived from the appropriate economic theory.

In my opinion, the Postal Service has not demonstrated that Dr. Bozzo's model is supported by appropriate economic theory. I have also noted deficiencies in the statement of the function being estimated, the selection of variables, the treatment of the network, the time frame, and cost minimization.

[75] Toda, *op.cit.* at 264. Dr. Toda actually found that some of the Soviet industries operated efficiently (a result he did not expect to find) and that some industries operated inefficiently. Regardless of the empirical findings, the theory is applicable insofar as it applies to firms that do not minimize costs. A partial explanation of Dr. Toda's empirical findings would be that the Soviet economy actually did, in some cases, operate efficiently.

C. Criterion 3: The Study Should Include a Discussion of the Modeling Approach and How It Is Consistent with the Underlying Data.

1. Another problem associated with Dr. Bozzo's work is his modeling of capital (as opposed to the accuracy of the QICAP variable itself). The use of capital affects future Postal Service costs.

Previous, current, and future investment efforts are important to the Postal Service and are focused on achieving productivity gains. The use of capital and the projection of the investment budget and efficiencies to be created has been highlighted by the Postal Service: "During 1999, the Postal Service continued its accelerated deployment of automation and mechanization equipment and software. This allowed us to increase our ability to place accurate barcodes on letter mail, while deploying additional equipment to sort the higher volumes of automated letter, flat, and package mail." [76]

(a) Dr. Hsiao has useful guidance on the modeling of capital and investment in economic models.

Dr. Hsiao's pioneering work on fixed effects has been referenced directly or indirectly throughout the analysis of volume variability.[77] A quote from the textbook *Econometric Models, Techniques, and Applications*, co-authored by Dr. Hsiao with Michael Intriligator and Ronald Bodkin, addresses the issue of capital in the econometric estimation process:

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[76] United States Postal Service, *1999 Comprehensive Statement on Postal Operations* at 50.

[77] Cheng Hsiao, *Analysis of Panel Data*, Cambridge University Press, 1986. Another book referenced is *Econometric Models, Techniques, and Applications,* with Michael D. Intriligator, Ronald G. Bodkin, and Cheng Hsiao, Prentice Hall, 1996, Second edition.

...The inputs should, in theory, be measured in terms of *services* of the input per unit of time, but such data are generally not available, so they are instead typically measured by the amount of the input utilized or available in the production process. Labor input is typically measured as labor hours employed per year, but it is also sometimes measured as number of employees. Capital input is typically measured by the net capital stock (net of depreciation), but it is also sometimes measured by the gross capital stock and by certain direct measures (e.g., number of tractors in use for agriculture)....

Of these variables, the one that creates the most problems is the capital input. While data on output and labor are generally available, data on capital are either not available or of questionable validity. Enormously complex problems of measurement arise with respect to capital as an input to the production process. First, capital generally represents an aggregation of very diverse components, including various types of machines, plant, inventories, and so on. Even machines of the same type may cause aggregation problems if they are of different vintages, with different technical characteristics, particularly different levels of productivity or efficiency. Second, some capital is rented but most is owned. For the capital stock that is owned, however, it is necessary to impute rental values to take account of capital services. Such an imputation depends, in part, on depreciation of capital. Depreciation figures are generally unrealistic, however, since they entail both tax avoidance by the firm and the creation by the tax authorities of incentives to invest via accelerated depreciation. Third there is the problem of capacity utilization. Only capital that is actually utilized should be treated as an input, so measured capital should be adjusted for capacity utilization. Accurate data on capacity utilization are, however, difficult or impossible to obtain.[11] Other problems could be cited as well, but all these suggest that, if at all possible, the use of an explicit measure of the capital stock should be avoided, since it is virtually impossible to find data adequately representing capital stock.[78]

11 An early approach to capacity utilization was to assume that the percentage of capital utilized was the same as the percentage of labor utilized and thus to reduce the total capital available by the (labor) unemployment rate, as in Solow (1957). More recently, there are various methods used to adjust capital for the degree of utilization which are independent of the unemployment rate. For example, the Wharton capacity utilization rate method assumes 100% utilization at local peaks of the industry output series, with capacity assumed to grow linearly from peak to peak. Capacity utilization is then obtained as the percentage of output relative to the value obtained on the linearly interpolated capacity series.

78 Intriligator, Bodkin, and Hsiao, *op.cit.* at 284-85.

(b) Dr. Bozzo has not modeled capital in a way that would meet the criteria outlined by Drs. Intriligator, Bodkin, and Hsiao.

Dr. Bozzo's approach does not meet the criteria outlined in the above quote. Dr. Bozzo has no measure of capacity utilization in his equations. Mail processing is a factory batch processing/job shop type of process. In analyzing factory operations, capacity utilization has a strong impact on cost performance. This is a potentially very important variable omitted from the analysis. In addition, it is not clear whether capital is appropriately modeled as an exogenous variable (as I believe Dr. Bozzo has done), or as an endogenous variable in a simultaneous equation system.

On the subject of the capital variable, Dr. Bozzo indicates that:

> With respect to the capital variable, my inclusion of the capital quantity rather than price is appropriate for a treatment of capital as a "quasi-fixed" factor. While I would expect capital costs to be volume-variable to some degree (possibly to the same degree as labor costs as discussed in USPS-T-15 at pages 39-41), I would nevertheless expect that the nature of the Postal Service's capital planning and deployment processes is such that capital and labor are not simultaneously determined, but rather that the available capital is taken as a "given" when labor work assignments are made.[79]

Dr. Bozzo indicates that capital is neither exogenous nor endogenous;[80] such a situation is impossible. Accordingly, some review of the specification of the econometric estimating model is needed.

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[79] OCA/USPS-T-15-56(b), Tr. 15/6359.

[80] Tr. 15/6414.

2. Witness Degen's testimony is a major input to the understanding and modeling of postal mail processing.

Witness Degen presents information on the physical and operational nature of mail processing as related to volume variability:

> ...I show that the structure of mail processing operations does not support the assumption that volume-variability factors should uniformly equal 100 percent. My analysis of the structure of mail processing operations also reveals that the pooled regression approach advocated by OCA witness Smith and the cross-sectional analysis favored by UPS witness Neels, in Docket No. R97-1, potentially ignores (sic) features of the Postal Service network and operations that are vital to distinguishing the cost effects of volume changes from the effects of non-volume factors.[81]

Mr. Degen raises two important issues in his testimony[82]:

- Mail processing operations have cost causing characteristics related to their location, service area, and role within the Postal Service's network that will not change as a result of a small, sustained increase in volume.
- For a small, sustained, and representative increase in national RPW, all other factors remaining the same, volume will increase workload in all, or nearly all, plants.

Witness Degen's discussion of the postal network--the ways in which the mail processing plants interact--suggests that volume variability should more appropriately be evaluated at the plant or inter-plant facilities network level, rather than in terms of activity costs on the mail processing plant floor. In examining the current Postal Service

[81] USPS-T-16 at 4, line 23 through 5, line 6.

[82] USPS-T-16 at 6, lines 18-23.

network, he notes in Section 2 of his testimony that over 30,000 post offices and other delivery units are networked, with mail processing being performed in large plants as well as other offices. He indicates that plants can sort mail as well serve as intermediate trans-shipment and processing points for various sections of the network.

In addition, the 21 Bulk Mail Centers (BMCs) constitute a separate network of processing facilities for specialized Standard Mail (A) and (B). BMCs sort incoming Standard Mail parcels to 5 digit ZIP codes for delivery units in their service territories, and also sort outgoing parcels to other BMCs. The role of BMCs in processing non-parcel Standard Mail (A) varies, but it usually involves sack, tray, and bundle sorting and the cross-docking of pallets (no piece sortation of letters and flats). Mr. Degen indicates that the network of processing plants is not static, but has involved the addition of nodes as the nation has grown and its population distribution has changed.

Mr. Degen concludes in Section 3 of his testimony that national volume growth affects the workload in the entire network. He states, "The geographic distribution of increase in national volume, and hence of volume-related workload growth, for mail processing plants, is a key element of my analysis of the relationship between mail processing labor costs and mail volumes." He continues "...I must conclude that the additional volumes will cause workload growth throughout the network."[83]

Mr. Degen's testimony reinforces my conclusion that postal costs are strongly influenced by the interaction of mail processing plants and that the longer-run analysis of the relationship between cost and volume is appropriate--*i.e.* considering volume, not

[83] USPS-T-16 at 15, lines 9-12 and at 15, lines 20-21.

in terms of its behavior in any one processing plant, but rather on an overall basis as volume is adjusted: such an approach would look at the effect of a change in volume on total cost. Accordingly, the "between" analysis presented by Dr. Bozzo, based on the arithmetic means of cost data appears to be more appropriate than is a fixed effects approach. Theoretically, one strives to more closely attain the estimation of longer-run costs (the types of costs that would vary as the nodes of the network changed as delineated by Mr. Degen), rather than the short- run cost estimation presented by Dr. Bozzo.

In Section 5 of his testimony, Mr. Degen extensively presents a graphical analysis of the impact of volume growth. To quote Mr. Degen:

> In questioning Dr. Bradley on his testimony in Docket No. R97-1, the Commission used a plot of TPH and hours from the manual letter cost pool to imply that visual inspection of the plot indicated 100 percent volume-variability for that cost pool. Dr. Bozzo thoroughly addresses the issue of graphical representation and analysis of the MODS data in his testimony, but I would also like to discuss it here because the pictures succinctly illustrate how ignoring non-volume characteristics of plants can lead to a biased, misleading understanding of the hours-volume relationship. [84]

Mr. Degen maintains that a graph of hours against volume can result in the erroneous conclusion that hours will vary in direct proportion to volume. The error, in Mr. Degen's opinion, is caused by the absence of information on network and plant characteristics. However, the argument for 100 percent volume variability is visually compelling, as will be discussed subsequently.

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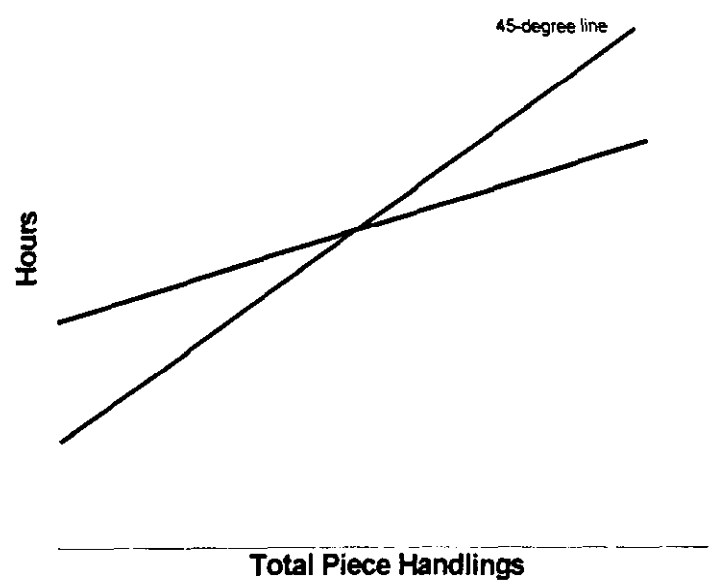
[84] USPS-T-16 at 24, lines 6 through 13.

The issue of the correct estimation of volume variability is best addressed by examining Mr. Degen's graphs.[85] Mr. Degen's graphs can be used to justify any of the three techniques under consideration in this case—fixed effects, pooled, or "between." As will be shown, the fixed effects approach is unsuitable: a simple review of the data shows that the eye (and economic logic) suggests the fixed effects approach is wrong.

Figure 1 of Mr. Degen's testimony, reproduced here, shows the "true" cost structure of a mail processing operation for a hypothetical mail processing plant. By "true" or "underlying" cost structure he means the systematic, non-stochastic component of the hours/pieces relationship.

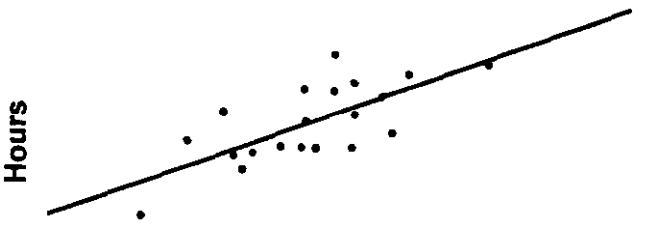
Figure 1
The Underlying Cost Structure for a Plant



[85] I do not imply that Mr. Degen would agree with any of my analysis; I would expect him to disagree. I use his graphs to show that a convincing argument can be made for the possibility of essentially 100 percent volume variability.

Volume variability is less than 100 percent for the hypothetical plant in Figure 1.[86] At some times during plant operation, the plant will be operating at relatively high volume (suggesting a high level of capacity utilization), and at other times the plant will be at a lower volume of TPH (with a lower level of capacity utilization).

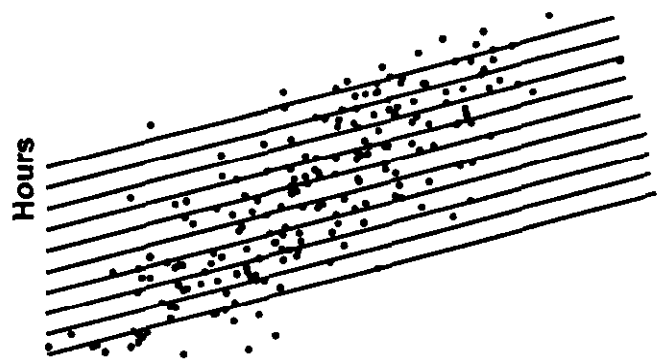
Figure 2
Observable Data from the Underlying Cost Structure
with Random Noise for One Plant



In Figure 2 of his testimony, Mr. Degen shows simulated sample data for the same plant generated by adding random noise to the underlying hours and pieces relationship plotted in Figure 1.

[86] This is exactly what one would expect, given that this is a short-run diagram relating small changes in hours and TPH.

Figure 3
Data for Ten Plants with Similar Cost Structures
but Different Levels of Efficiency
Illustrating True Cost Structure

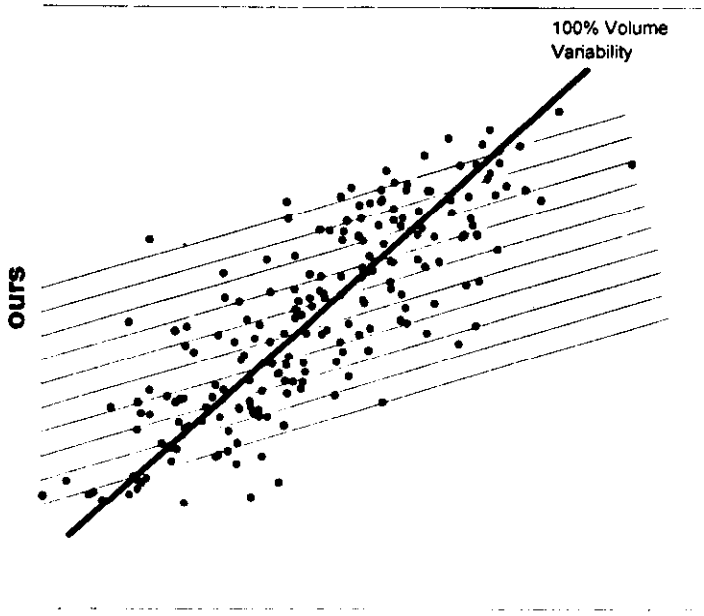


Total Piece Handlings

Mr. Degen's Figure 3 presents ten plants with cost structures similar to the plant in Figure 2, but with different levels of efficiency.[87] For each plant, Mr. Degen plotted a line analogous to that plotted in Figure 1. Accordingly, there are ten sets of points and ten lines, all of them short run.

[87] Mr. Degen and Dr. Bozzo attribute the differences in efficiency to differences in networks and other factors not associated with volume of mail. Nevertheless, the Postal Service has extensive testimony and comments on investment and efforts to achieve lower costs. Treating these fixed effects factors as exogenous rather than endogenous to the capital investment process seems to be wrong.

Figure 4
Data for Ten Plants with Similar Cost Structures
but Different Levels of Efficiency
Illustrating Misinterpretation of Cost Structure



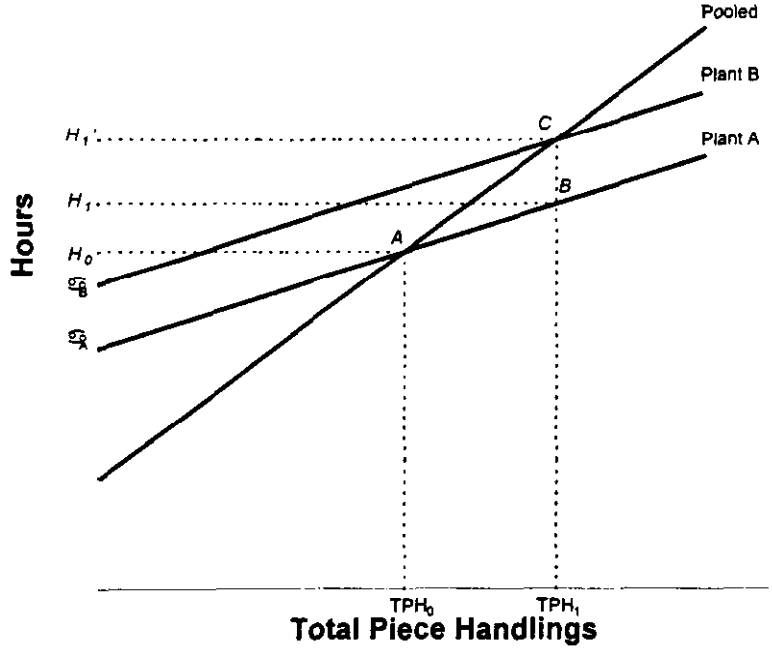
In Figure 4, the lines presented in Figure 3, which represented the formerly examined short-term hypotheses of the relationship between hours and pieces, are suppressed. An overall trend line is added to the diagram. Instead of visualizing the data as in Figure 3--ten separate lines for ten facilities--the data are considered on a combined basis.[88]

[88] Mr. Degen's title for Figure 3, referencing the "true cost structure," is correct in the sense that the cost structure is short run. Similarly, the title for Figure 4, referencing a "Misinterpretation of Cost Structure," was included in the reproduced figure, but, in contrast to Mr. Degen, I believe that the true cost structure is the line he has labeled "100% Volume Variability".

Whatever interpretation one wishes to give to the data is dependent on which lines one looks at--*i.e.* one could derive a fixed effects model from Figure 3; or alternatively one could define a pooled model from a review of Figure 4, recognizing that additional variables would be needed and that any two variables approach is inadequate insofar as it may omit important information.

From a review of the graphs, two distinctly different alternatives are possible. The conclusion from the underlying model is essentially determined once one has specified the choice of model; all that then remains is the model estimation. The issue is then the selection of the appropriate line for estimation.

Figure 5
Analysis of Response to Volume Growth



Turning to Mr. Degen's Figure 5, two plants are examined: Plant A and Plant B. Assume that Plant A is designed and sized correctly, based on Mr. Degen's theory of the mail processing network. Assume that optimal capacity is at "A", but that the plant frequently operates in the short run, and the line shows these various levels of operation. Assume that Plant B is designed and sized correctly for a higher level of TPH, and that the optimal capacity is at point C. Again, on a short-run basis the plant may operate anywhere along the line. The two most important points in the diagram are points A and C. They represent the real labor costs of processing mail at each of the plants when operating at plant design capacity--the level for which they were designed, based on the evolving mail processing network as described by Mr. Degen.

Figure 5 has two types of plots in it. The facility by facility plots (labeled "Plant A" and "Plant B") are the types of plots that both Dr. Bradley and Dr. Bozzo generate and estimate. These are short-term plots of data. Alternatively, one could allow for the treatment of the data on a pooled basis or cross sectional basis. In that case, one would estimate the line AC. Such a modeling approach would be consistent with the data and an underlying longer-term capacity expansion path.

The mail-processing network consists of over 300 plants. Accordingly, there are variously sized plants, and in a real world environment costs exhibit stochastic properties. A pooled regression line could be generated. It would be based, not on two plants, but based on confirmed data from approximately 300 plants. Alternatively, a cross sectional regression line based on the arithmetic means of the plants could be generated. The appropriate econometric techniques and variables would need to be accounted for in order to avoid problems of omitted variables. The results could be 100

percent volume variable, or some other number either greater than (or less than) 100 percent volume variable. The results would not be known until the appropriate variables were used. Such an analysis correctly using all relevant variables has not yet been performed in this case. However, on a preliminary basis, there are the pooled and "between" regressions in Dr. Bozzo's testimony, which are unsatisfactory but also the best currently available.

Of the approaches presented by Dr. Bozzo, it would appear that the cross sectional approach may be the "least bad." For each mail processing plant, the data are averaged (i.e., a mean is determined); a regression analysis is then performed on the sites. This is a cross sectional approach, and based on Mr. Degen's testimony, appears to be superior to either the fixed effects or pooled models. It examines costs as plant size varies, based on the plants sized for the postal network.

The results from the various models considered by Dr. Bozzo are set forth in Table 5. I have indicated that the "between" model, a type of cross sectional model generated by Dr. Bozzo, is the "least bad" of the models. In general, cross sectional data are assumed to show a longer-run equilibrium, and the line has all of the plants--*i.e.* all of the cross sectional data--thereby having both short-term and longer- term aspects. The major statistical problems associated with the model have been well documented. However, at this point, it is the only model "left standing." Accordingly, if the Commission should conclude that some action is necessary in adopting a model, I find this to be the "least bad" model. I do not recommend adoption of the "between" model in view of the underlying problems with the data and the study. I recommend adoption of 100 percent variability until a different approach is shown to be reasonable.

Table 5
Variabilities--Dr. Bradley, Fixed Effects, Between, Pooled, and Random

Variabilities Using Different Methods

Activity	Dr. Bradley	Dr. Bozzo Fixed Effects	Dr. Bozzo Between	Dr. Bozzo Pooled	Dr. Bozzo Random Effects	Total Cost $--000
BCS Sorting	0.945	0.895	1.044	0.931	0.916	1,043,841
OCR Sorting	0.786	0.751	1.101	0.862	0.821	219,070
FSM Sorting	0.918	0.817	1.026	0.913	0.880	1,042,369
LSM	0.905	0.954	0.913	0.922	0.918	78,765
SPBS Non Priority	0.469	0.641	0.889	0.724	0.662	283,275
SPBS Priority	0.802	0.641	0.889	0.724	0.662	82,447
Manual Flats	0.866	0.772	0.963	0.842	0.803	459,933
Manual Letters	0.797	0.735	0.906	0.845	0.790	1,563,963
Manual Parcels	0.395	0.522	0.730	0.645	0.615	60,593
Manl Priority Sorting	0.448	0.522	0.748	0.642	0.627	259,762
Cancl. And Mail Prep	0.654	0.549	0.845	0.643	0.569	295,957
Total						5,389,975

Attributable Costs Based on Various Variabilities

	Total Cost $--000	Dr. Bradley $--000	Dr. Bozzo Fixed Effects $--000	Dr. Bozzo Between $--000	Dr. Bozzo Pooled $--000	Dr. Bozzo Random Effects $--000
BCS Sorting	1,043,841	986,430	934,238	1,089,770	971,816	956,158
OCR Sorting	219,070	172,189	164,522	241,196	188,838	179,856
FSM Sorting	1,042,369	956,895	851,615	1,069,471	951,683	917,285
LSM	78,765	71,282	75,142	71,912	72,621	72,306
SPBS Non Priority	283,275	132,856	181,579	251,831	205,091	187,528
SPBS Priority	82,447	66,122	52,849	73,295	59,692	54,580
Manual Flats	459,933	398,302	355,068	442,915	387,264	369,326
Manual Letters	1,563,963	1,246,479	1,149,513	1,416,950	1,321,549	1,235,531
Manual Parcels	60,593	23,934	31,630	44,233	39,082	37,265
Manl Pri Mail Sorting	259,762	116,373	135,596	194,302	166,767	162,871
Cancl and Mail Prep	295,957	193,556	162,480	250,084	190,300	168,400
Total	5,389,975	4,364,418	4,094,231	5,145,960	4,554,704	4,341,106

3. Witness Degen's testimony is consistent with the application of intuition and common sense that indicates the volume variability for mail processing approaches 100 percent.

The above analysis of Mr. Degen's testimony is substantiated if the problem is looked at from simply the perspective of intuition and common sense.

In addressing the issue of data and modeling, Dr. Bozzo states in his testimony:

> During the hearings on the Postal Service's direct case in Docket No. R97-1, Chairman Gleiman asked Dr. Bradley to confirm the intuition
>
> > ...that if costs vary 100 percent with volume, the graph of those costs and the volume data points should resemble a straight line with a 1-to-1 slope. Docket No. R97-1, Tr. 11/5578 at 4-6.
>
> Dr. Bradley agreed, and even added that the line should go through the origin (Id., at 8-9, 11).[21] In my opinion, Dr. Bradley should not have confirmed Chairman Gleiman's intuition. It has been understood since Docket No. R71-1 that to measure "volume-variability," it is necessary to hold constant the non-volume factors that affect costs.[89]
>
> 21 Dr. Bradley's statement that the line should additionally pass through the origin was in error. As a general matter, the cost surface passing through the origin is neither necessary nor sufficient for the 100 percent volume-variability result.

Dr. Bozzo apparently believes that the multivariate nature of the modeling process makes the bivariate graphs irrelevant. However, the graphs are visually compelling in showing that hours and TPH vary together closely. The Appendix contains plots of the number of hours and TPH for some of the mail processing activities studied by Dr. Bozzo. Dr. Bozzo has referred to Dr. Bradley's data, so the graphs are based on Dr. Bradley's data. The graphs are open to the same criticisms

89 USPS-T-15 at 59, lines 4 through 13.

voiced in Docket No. R97-1. Only two pieces of data are plotted. However, all of the information actually contained in Dr. Bradley's data set and which was actually collected from the field operations (and remaining after his scrubbing) is also present, recognizing that data are not denoted by accounting period. Data were obtained from Dr. Bradley's data set in order to be consistent with Dr. Bozzo's comments. I have previously concluded that the plots are consistent with a high degree of volume variability, possibly even 100 percent volume variability. This is a simple and intuitively plausible initial conclusion. This would appear to be the case for a number of the activities. An ordinary least squares line (which does not consider any of the myriad of issues associated with serial correlation, lack of variables, times series nature of the data, omitted variables, etc.) has the characteristics presented in Table 6.[90]

Table 6
OLS Summary by Selected Activities

Activity	Regressor	RSquare
OCS	0.19	0.77
BCS	1.01	0.94
LSM	0.98	0.97
FSM	1.01	0.96
MANL	1.05	0.90
MANF	1.09	0.90

The regression lines are econometrically indefensible insofar as the regression does not consider the myriad of issues that contribute to the understanding of the TPH/hours relationships. However, the lines do show that a simple visualization of a straight line through the data suggests a high level of volume variability, resulting in a high R

[90] The regression runs are provided in Library Reference OCA-LR-I-2.

square. A modeling approach consistent with the data would be the "between" model or the pooled model.

4. In terms of identifying a major factor driving cost, intuition appears reasonable.

Dr. Bradley's analysis included a large number of variables in addition to hours and TPH. There is, however, a difference between the number of variables and the amount of information presented. All of the variables were either derived from the scrubbed data of hours and TPH via cross products, or were simply time trend or dummy variables. Except for time trend and seasonal information, the actual data show that TPH and hours vary together closely.

The issues under consideration are the correct estimation of the relationship, appropriate variables, the underlying methodology, and whether such estimation would yield 100 percent variability. The graphs derived from the application of intuition are compelling and suggest the existence of a relationship for high volume variability, probably at or approaching 100 percent. A correctly constructed econometric model might also reach such a conclusion.

5. In conclusion, Dr. Bozzo's choice of econometric model is inconsistent with the economic modeling of the postal process.

The level of econometric sophistication evidenced previously by Dr. Bradley and currently by Dr. Bozzo is clear. The major concern with their econometric estimation work is the inappropriate choice of a model for estimation. The "between" model is the more appropriate model at this time. The microeconomic assumptions underlying Dr. Bozzo's econometric model are at best muddled. We are faced with analyses of non

cost minimizing firms, cost functions that have become labor demand functions, and state of the art price theory which is not organized in a coherent fashion or logical progression. Furthermore, the underlying data are deficient, both in terms of variables omitted and variables included (such as QICAP and the manual ratio).

D. Criterion 4: A Correct Estimation Procedure which Is Suitable to the Estimation Needs at Hand Should Be Used.

1. The "between" model is currently the "least bad" model available.

The deficiencies of the fixed effects approach as it has been applied have been outlined in Docket No. R97-1, where it was rejected. Dr. Bozzo's overall approach is fundamentally identical to that of Dr. Bradley. Accordingly, the fixed effects model is unsuitable at this point.

Deficiencies in the availability of variables also render an application of the pooled model unsatisfactory. Without a measure of capacity, capital, and networks (among other variable deficiencies), the pooled model is subject to specification error.

The use of cross sectional models allows for an analysis of costs as facilities vary. The "between" model has data available on a cross sectional basis, but the model is subject to deficiencies in the set of variables available. There have been a number of criticisms of the econometric estimation deficiencies of the "between" model, as outlined by Dr. Bradley. However, the "between" model permits an analysis of labor demand based on size of the facilities. Accordingly, the "between" model has relevance to the current proceeding and is the "least bad" model.

In addition to deficiencies in Dr. Bozzo's current models, several major areas of the methodology need potential improvement. First, at the activity level, investment

almost certainly has a major impact on the costs. However, investment is, in turn, a function of TPF or TPH, so in a sense investment is an endogenous variable to the mail handling process. It may be appropriate to model simultaneously both investment and labor hours. Dr. Bozzo has not examined this area. Second, Dr. Bozzo's model treats each activity as if it were independent of every other activity in the mail processing plant. However, one would expect the efficiency, labor usage, investment requirements, and network aspects of the ten activities modeled to be significantly interrelated. This potential interrelationship could be due to some sharing of the workforce, the management, or the facilities. It is difficult to imagine that the cost of performing work in one activity is independent of other work performed in the plant.

2. In conclusion, Dr. Bozzo has not adopted a correct estimation procedure.

Dr. Bozzo's fixed effects approach is not acceptable. Assuming that the data could be improved, the appropriate variables developed, and a clear economic theory could be stated, one could perform the modeling effort using a pooled approach; but such an approach is not appropriate at this time. Accordingly, we are left with the "between" case as the "least bad." However, in view of the many uncertainties I have discussed, I do not view its adoption as appropriate.

On a longer-term basis, alternative modeling formations need to be considered, both in terms of the interrelationships of activities and whether some simultaneous estimation of investment and cost is appropriate. In modeling activities, the incidence of costs as a result of First Handling Pieces rather than TPF or TPH should be

examined. In summary, it is not yet even clear what the best modeling approach would be, but it is clear that there are a number of options that need to be explored.

E. Criterion 5: Results for Econometric Equations and Alternative Econometric Analyses Should Include a Discussion of the Values, Signs, and Other Relevant Information for the Variables.

Dr. Bozzo presents a variety of alternative econometric analyses, but they are all variants on his preferred methods. Fundamental changes and new modeling approaches have not been explored. Accordingly, while it is difficult to say that Dr. Bozzo has ignored Criterion 5, strictly speaking; it is also clear that this requirement needs to be applied to the study after the study has been redone. First, there needs to be a rework of the economic theory—with an improvement in presentation and more likely an exploration of multiple product production, simultaneous determination of output and investment, and an improved microeconomic analysis. Second, there needs to be a significant upgrading of the quality and availability of data. Finally, there needs to be the application of suitable estimating techniques. Therefore, the most important analyses have not yet been performed and any discussion at this time of values, signs, or other relevant information for variables is moot.

VII. CONCLUSIONS

A. Variabilities Were Traditionally Assumed To Be 100 Percent. The First Study, Performed by Dr. Bradley, Was Seriously Deficient.

The Commission has always applied a variability of 100 percent when attributing mail-processing costs. In Docket No. R97-1, the Postal Service reviewed the policy and presented a witness, Dr. Bradley, who proposed a new econometric model for mail processing operations to measure volume variability. That model purported to analyze the change in the estimated volume of mail processed with the estimated hours of labor required to process that volume. From this, he calculated the percentage change in labor hours for mail processing for each percentage change in the volume of mail, arriving at an estimate of volume variability. He concluded that the resulting volume variabilities for each of the several cost pools could be applied by Postal Service witness Degen. Dr. Bradley's volume variabilities were significantly lower than 100 percent, and the Postal Service contended that his variabilities should be applied rather than the traditional 100 percent variability used by the Commission.

Numerous objections were raised to Dr. Bradley's model specifications, his choice of regression techniques, and his handling of the data prior to running his regressions. The Commission's recommended decision specifically rejected Dr. Bradley's approach on several grounds and indicated that additional study was necessary before the Commission revised its approach to mail processing variability.

The Commission found fundamental deficiencies in the specifications for Dr. Bradley's model and discussed these problems in both its opinion and in greater detail in Appendix F to the Opinion. The Commission recognized that Dr. Bradley's model

failed to consider the impact of capital. The Commission noted that Dr. Bradley did not base his analysis upon a correctly specified cost function as indicated by the theory of production. The Commission also faulted Dr. Bradley's method of preparing the data for analysis, citing his several seemingly arbitrary restrictions and over-zealous scrubbing of the data prior to running regressions. The Commission recommended alternative approaches and further analysis. Finally, the Commission clearly indicated the fixed-effects model selected by Dr. Bradley in lieu of other possible regression models such as the pooled or the "between" model was not sufficiently supported and, in fact, had numerous infirmities.

B. Dr. Bozzo's Study Is also Seriously Deficient.

The Postal Service has now presented Dr. Bozzo's testimony that further analyzes mail processing costs, critiques Dr. Bradley's study, and responds to the Commission's R97-1 Opinion. Significantly, Dr. Bozzo reviewed the work of Dr. Bradley and that of other witnesses in Docket No. R97-1 and found that some criticisms of Dr. Bradley's work were valid. In response, Dr. Bozzo modified the methodology of Dr. Bradley.

While Dr. Bozzo purports to present a study meeting the objections expressed by the Commission in Docket No. R97-1, closer inspection indicates a startling similarity to the Postal Service's prior presentation that has been soundly rejected by the Commission. Dr. Bozzo continues to ground the analysis on the fixed effects regression model that the Commission essentially rejected in the Docket No. R97-1 opinion. Dr. Bozzo dresses up Dr. Bradley's defective cost function, renaming it a labor

demand function. He adds at least two variables affected by volume, "QICAP," and the heretofore unmodeled "network" characteristic. According to Dr. Bozzo, neither variable has ever been utilized by the Commission in considering segment 3 costs. The new Postal Service model is essentially Dr. Bradley revisited. Thus, without more, the Commission is faced with continuing to apply the traditional 100 percent volume variability to the ten cost pools.

The Commission may wish to attribute mail-processing costs for the ten cost pools on the basis of a variability analysis other than that in Docket No. R71-1 on which the Commission has based its traditional approach. Having independently reviewed the mail processing information and data supplied by the Postal Service and applied the appropriate classical economic theories, I conclude that upon the information now available, the cross sectional "between" model is the "least bad" of the models presented, although I do not advocate its adoption. In fact, the "between" model results in costs that are 95 percent attributable; the use of the model, which is known to be subject to error is, therefore, hardly worth the effort.

I recommend, instead, that the Commission reject Dr. Bozzo's study and continue to apply the traditional variability to the ten cost pools in the study. Alternatively, I recommend the "between" model as the "least bad" of the models presented by Dr. Bozzo. I provided OCA witness Thompson the list of those cost pools which should be modified to reflect a volume variability of 100 percent.

C. The Work that Has Been Reviewed Represents the Latest Part of a Major Modeling Effort.

Apparently, Dr. Bradley and Dr. Bozzo on a combined basis have spent approximately ten person years on the issue, and Dr. Bozzo has projected that there would be a significant additional effort involved in the completion of the work. The underlying economic theory is not set forth as clearly as is desired, so it is possible that there would be substantial theoretical modifications in the work as well as the extension of the work to additional activities, additional types of mail processing facilities, additional and/or improved data, and different estimating approaches.

I have discussed the work in terms of some of the criteria for evaluation set out in Appendix F of the Commission's opinion in Docket No. R97-1. By those standards, the work is not yet complete. Nevertheless, we are faced with the distressing fact that substantial effort as well as significant elapsed time has occurred with no production of a final study. I recommend that the Commission and the Postal Service consider the establishment of a working group to discuss, evaluate, and comment on theoretical, data, and modeling approaches in an effort to bring these issues to a conclusion. Obviously such a group would require the honest and effective participation of all of the parties involved.

Whether through a working group or otherwise, there are a number of deficiencies in the work to be addressed. First, the underlying economic assumptions need to be presented in a more comprehensible manner, with particular emphasis focused on assumptions about homotheticity, economic efficiency, networks, and the nature of the function being estimated.

Second, there need to be improvements in the data, particularly as related to the variables QICAP, manual ratio, and capacity utilization. It is important that the relationship of the investment data to the activity being estimated is carefully considered (if the activity approach is pursued). Even if the QICAP variable were not meaningless, it would not measure the level of capital associated with an activity in its current state.

Third, additional explanatory variables may be needed, particularly in terms of the network.

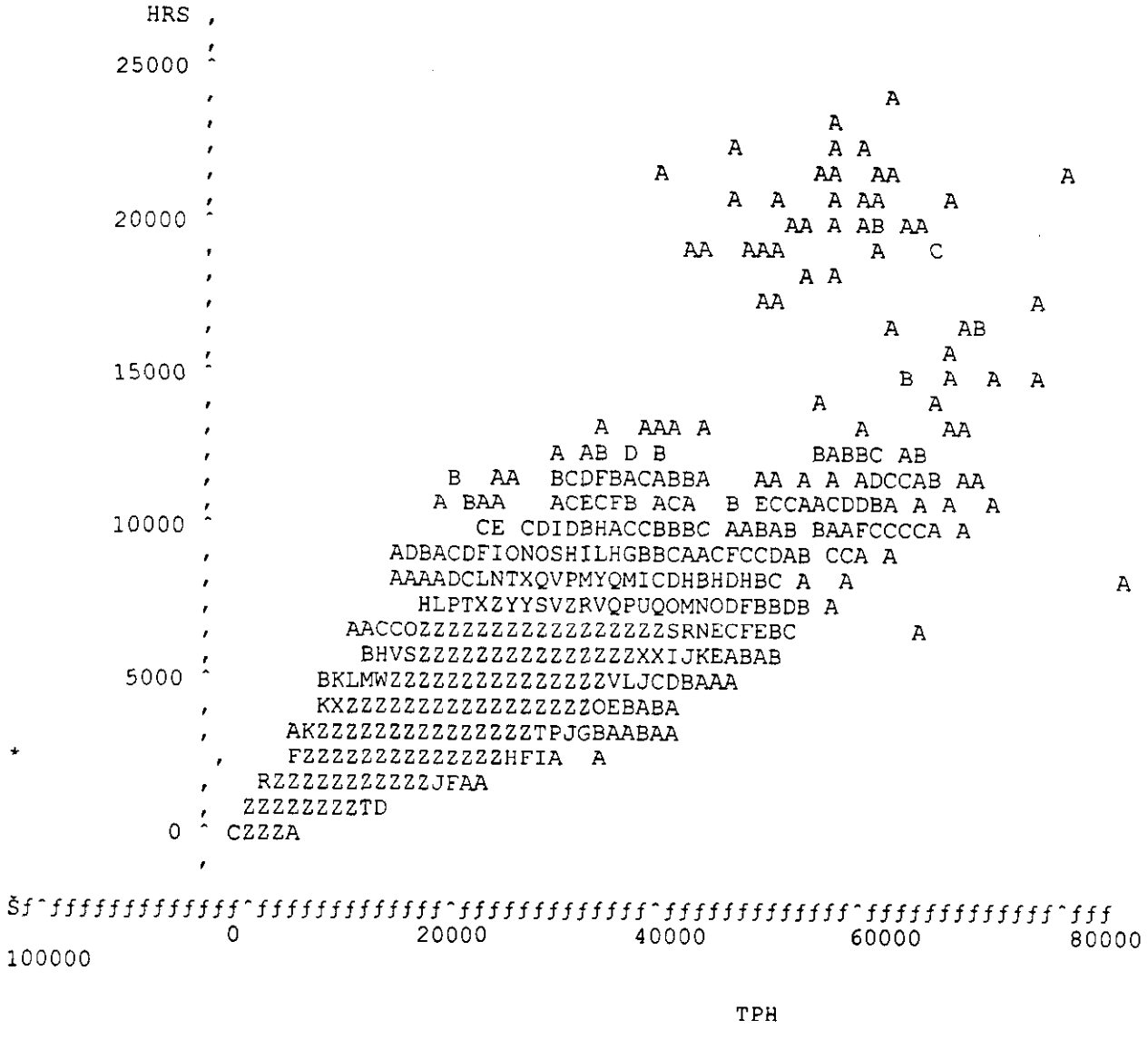
Fourth, recognizing the network aspects and longer run aspects of the mail processing process, the short-run fixed effects analysis presented is unsuitable; a longer-run analysis is needed.

Finally, my comments are based on a four-month examination of Dr. Bozzo's work. This is the necessary consequence of the time constraints of a rate case, but is not adequate from a scientific analysis point of view. Accordingly, I urge the Commission to recommend the establishment of a working group to consider this issue in detail.

APPENDIX

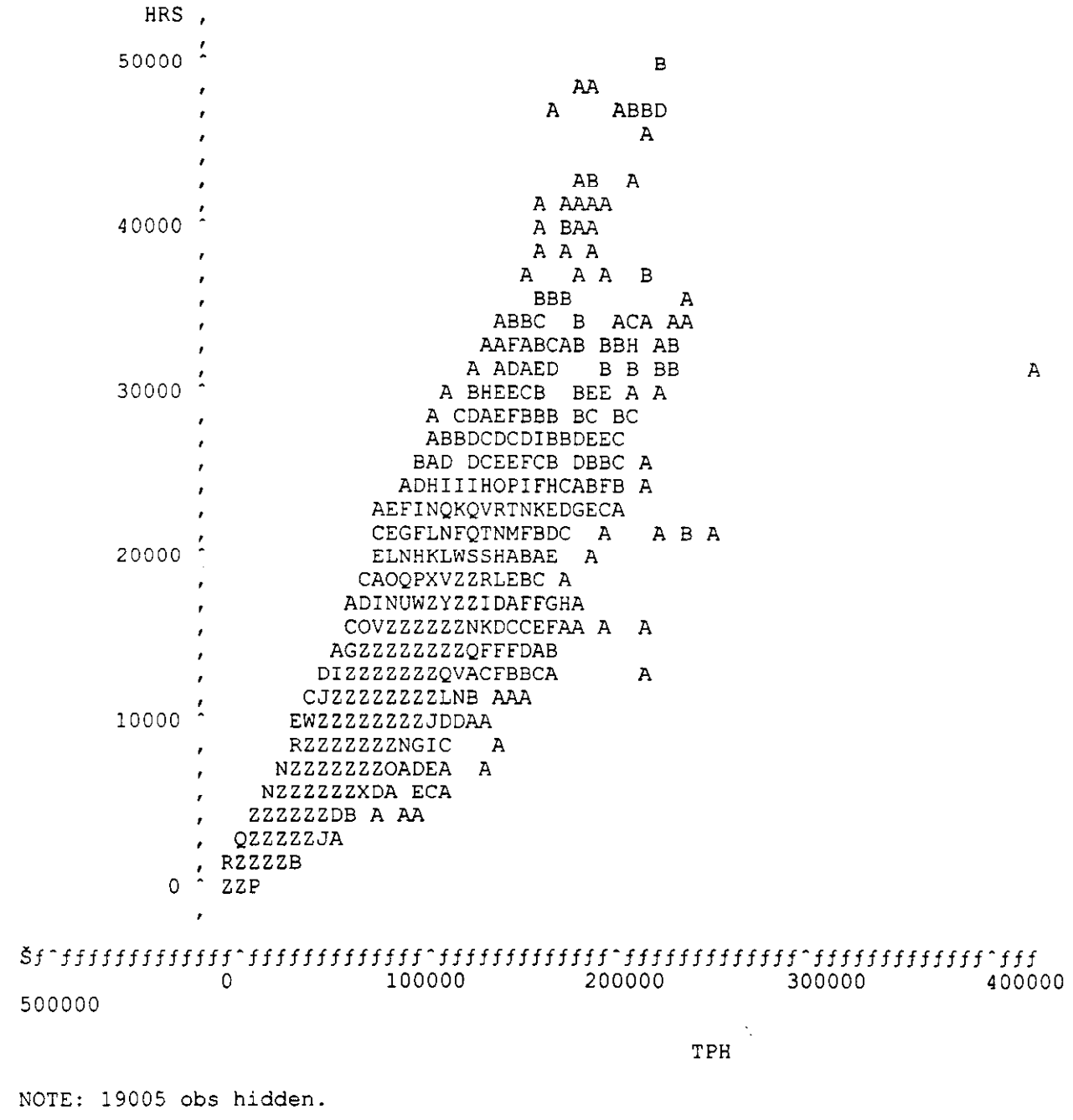
OCR OPERATIONS/ HOURS ON TPH
USING ONLY CONTINUOUS DATA FROM 8801-9613
INCLUDING OFFICES @ LEAST 39 OBS/LAG MODEL
USES 12 AP DUMMIES TO CAPTURE SEASONAL EFFECTS

Plot of HRS*TPH. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 13796 obs hidden.

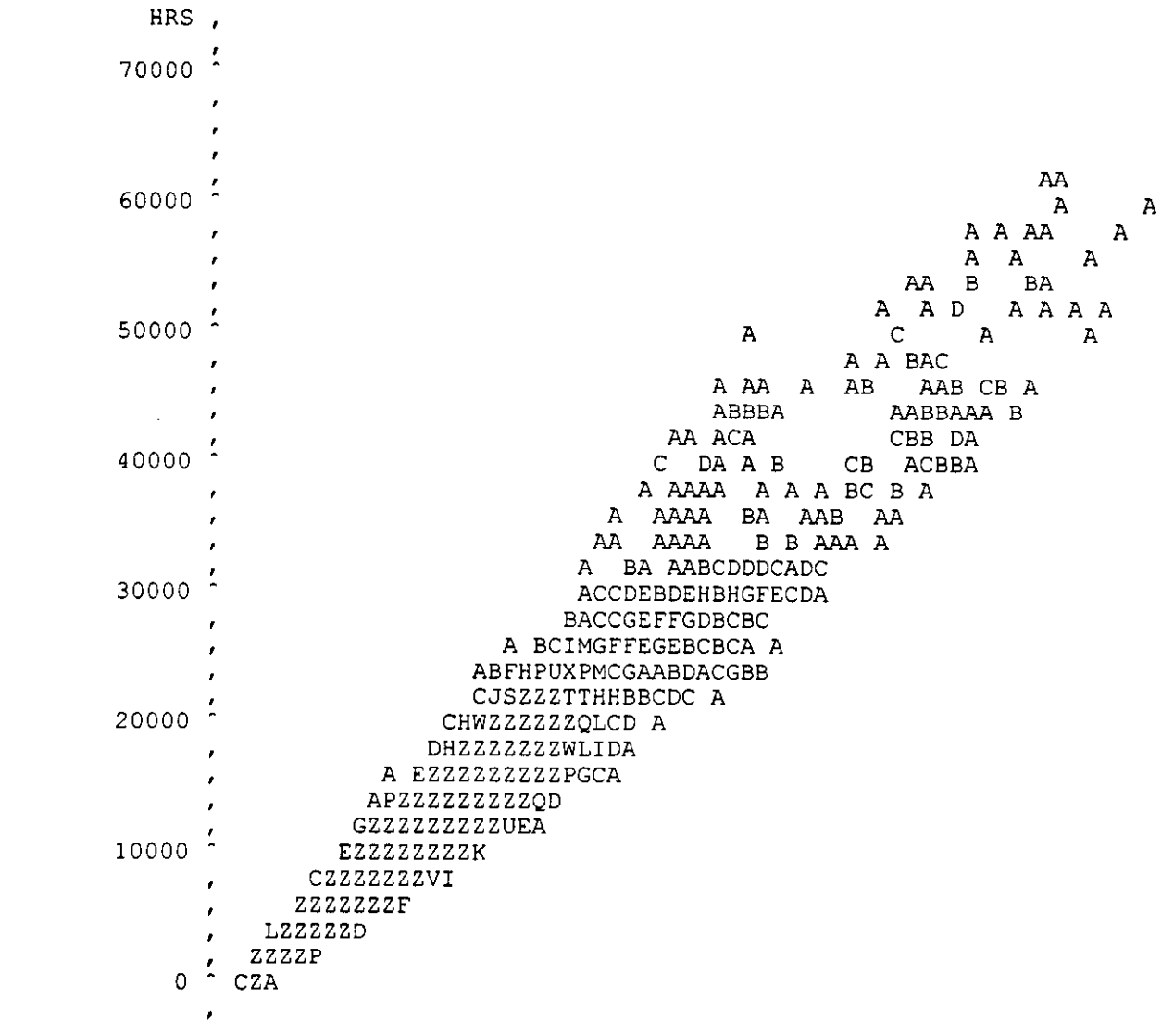
BCS OPERATIONS/ HOURS ON TPH
USING ONLY CONTINUOUS DATA FROM 8801-9613
INCLUDING OFFICES @ LEAST 39 OBS/LAG MODEL
USES 12 AP DUMMIES TO CAPTURE SEASONAL EFFECTS
Plot of HRS*TPH. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 19005 obs hidden.

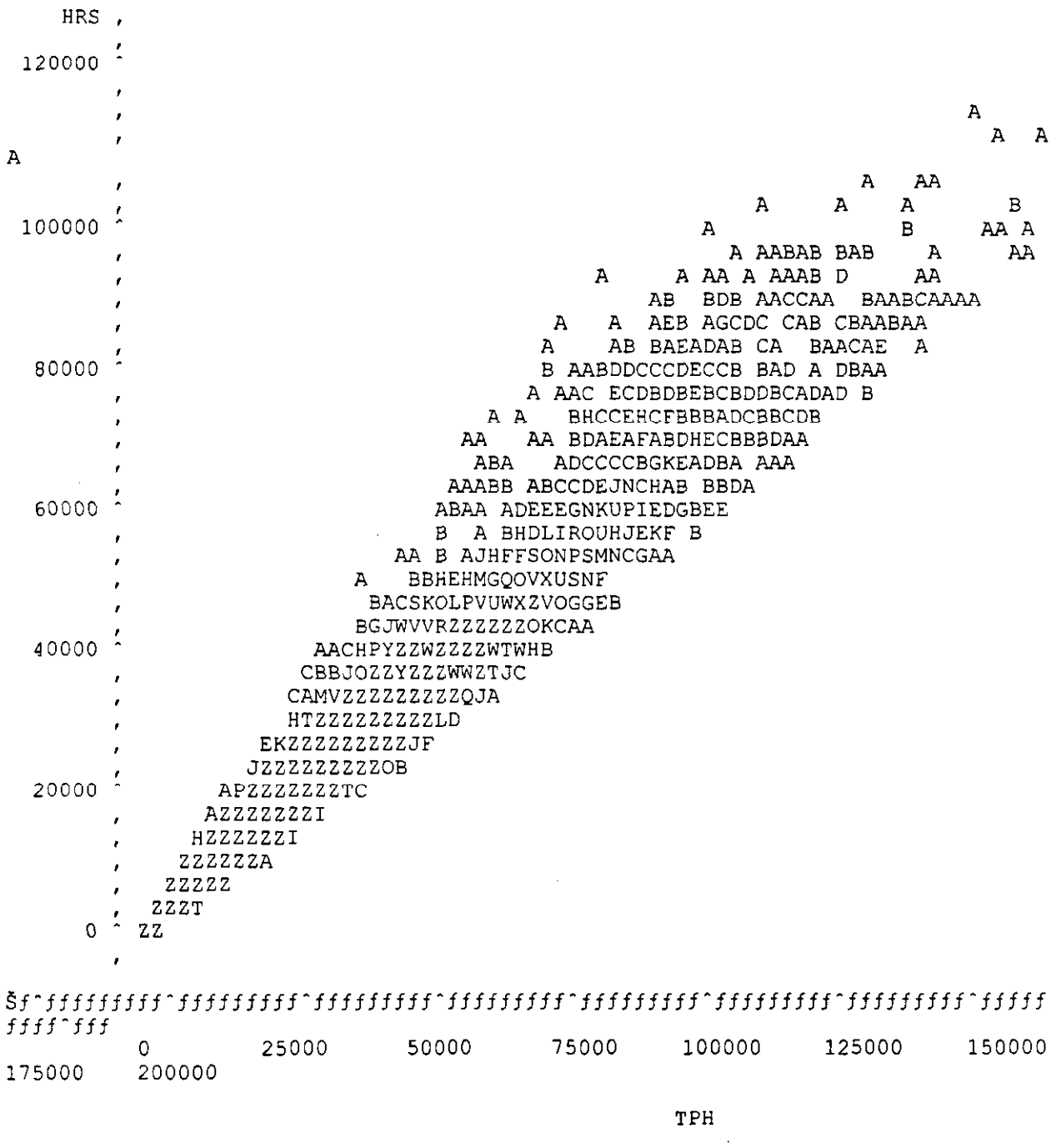
FSM OPERATIONS/ HOURS ON TPH
USING ONLY CONTINUOUS DATA FROM 8801-9613
INCLUDING OFFICES @ LEAST 39 OBS/LAG MODEL
USES 12 AP DUMMIES TO CAPTURE SEASONAL EFFECTS

Plot of HRS*TPH. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 15019 obs hidden.

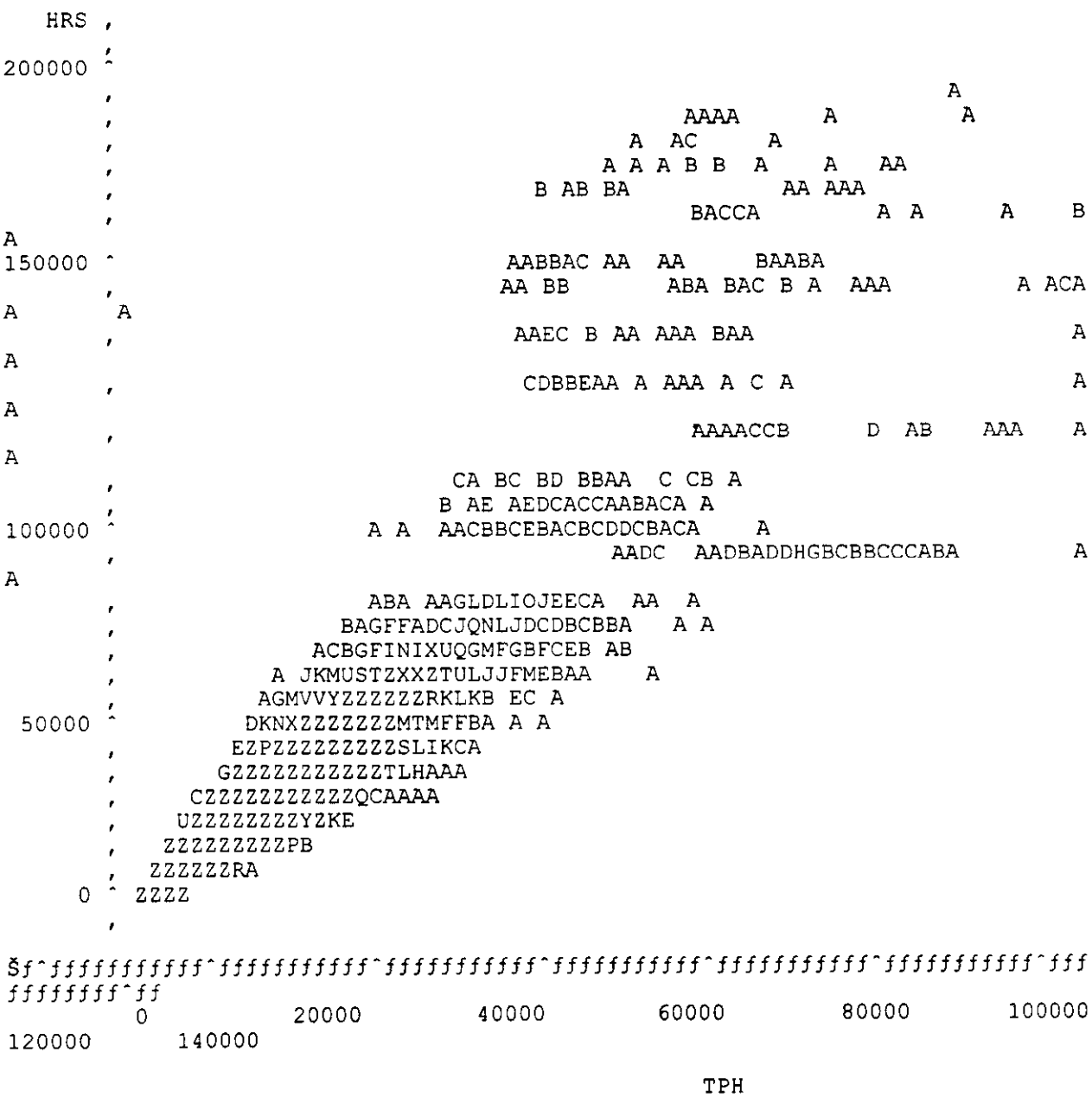
LSM OPERATIONS/ HOURS ON TPH
USING ONLY CONTINUOUS DATA FROM 8801-9613
INCLUDING OFFICES @ LEAST 39 OBS/LAG MODEL
USES 12 AP DUMMIES TO CAPTURE SEASONAL EFFECTS
Plot of HRS*TPH. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 15313 obs hidden.

MANUAL LETTER OPERATIONS/ HOURS ON TPH
USING ONLY CONTINUOUS DATA FROM 8801-9613
INCLUDING OFFICES @ LEAST 39 OBS/LAG MODEL
USES 12 AP DUMMIES TO CAPTURE SEASONAL EFFECTS

Plot of HRS*TPH. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 21328 obs hidden.

MANUAL FLAT OPERATIONS/ HOURS ON TPH
USING ONLY CONTINUOUS DATA FROM 8801-9613
INCLUDING OFFICES @ LEAST 39 OBS/LAG MODEL
USES 12 AP DUMMIES TO CAPTURE SEASONAL EFFECTS
Plot of HRS*TPH. Legend: A = 1 obs, B = 2 obs, etc.

NOTE: 20608 obs hidden.